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Berks Sand Pit

Feasibility Study Final Report

October 1988

Prepared For

ennsylvania Department Of Environmental Resources

Harrisburg, Pennsylvania

PENNSYLVANIA DER

Prepared By

Baker Engineers

Baker / TSA Inc.

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FEASIBILITY STUDY REPORT

BERKS SAND PIT
SUPERFUND SITE
LONGSWAMP TOWNSHIP, PENNSYLVANIA

Submitted to

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Harrisburg, Pennsylvania

Submitted by

BAKER/TSA, INC.
Coraopolis, Pennsylvania

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

This Feasibility Study (FS) was conducted in order to develop and analyze feasible Remedial Action Alternatives (RAAs) to resolve site problems caused by the contamination of groundwater, surface water, and surface water sediments. The alternatives presented in this report are based on the site characterization information contained in the final Remedial Investigation Report.

Uncontrolled and non-permitted clandestine disposal of hazardous wastes in the site area resulted in the degradation of the groundwater, which was being used by the residents as their sole source of potable water. Public concern prompted the Pennsylvania Department of Environmental Resources (PADER) and the U. S. EPA Region III to investigate the problem. An emergency cleanup action was undertaken by the EPA and the site conditions were evaluated using the Hazard Ranking System (HRS). The site was found to be eligible for inclusion on the National Priorities List (NPL).

The sampling results and subsequent risk assessment revealed that the only media that exhibited concentrations of contaminants above background levels were the groundwater and soil. Evaluation of the analytical data suggests that off-site contamination has probably resulted from previous disposal activities in the sand pit area. Concentrations of contaminants that pose a health threat, due to ingestion of drinking water, were encountered in water samples obtained from some residential and monitoring wells; these contaminants were identified as:

1,1-Dichloroethene	(DCE)
1,1,1-Trichloroethane	(TCA)
1,1-Dichloroethane	(DCA)
Tetrachloroethene	(PCE)

Seven feasible alternatives were developed: four of these remedy the site conditions through the collection and treatment of contaminated groundwater and sediments at surface seep locations. The seven alternatives (RAA No. 1 through RAA No. 7) were developed to address four levels of cleanup as suggested by EPA guidance documents. The seven alternatives and the cleanup categories they satisfy are listed as follows:

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Cleanup Category I: No Action

RAA No. 1 Continued monitoring of existing wells (groundwater) and surface water.

RAA No. 2 Surface water and groundwater monitoring, including the installation of additional monitoring wells.

Cleanup Category II: Alternatives That Prevent A Risk Increase To Human Health

RAA No. 3 Surface water and groundwater monitoring, including the installation of additional monitoring wells and installation of an alternate water supply system.

Cleanup Category III: Alternatives That Meet Or Exceed ARARs For Human Health

RAA No. 4 Surface water and groundwater monitoring, including the installation of additional monitoring wells; installation of an alternate water supply system; groundwater extraction; groundwater treatment by air stripping with optional liquid- and/or vapor-phase adsorption; discharge of treated water to the watershed (stream); and excavation, treatment and disposal of contaminated sediments.

RAA No. 5 Surface water and groundwater monitoring, including the installation of additional monitoring wells; installation of an alternate water supply system; groundwater extraction; groundwater treatment by carbon adsorption; discharge of treated water to the watershed (stream); and excavation, treatment and disposal of contaminated sediments.

Cleanup Category IV: Alternatives That Meet Or Exceed ARARs For Human Health And The Environment

RAA No. 6 Surface water and groundwater monitoring, including the installation of additional monitoring wells; installation of an alternate water supply system; groundwater extraction; groundwater treatment by air stripping with optional liquid- and/or vapor-phase carbon adsorption; discharge of

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treated water by reinjection into aquifer; excavation, treatment and disposal of contaminated sediments.

RAA No. 7 Surface water and groundwater monitoring, including the installation of additional monitoring wells; installation of an alternate water supply system; groundwater extraction; groundwater treatment by carbon adsorption; discharge of treated water by reinjection; excavation, treatment and disposal of contaminated sediments.

Tables ES-1, ES-2 and ES-3 provide summaries of the cost evaluation performed for the RAAs developed for the Berks Sand Pit Site.

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treated water by reinjection into aquifer; excavation, treatment and disposal of contaminated sediments.

RAA No. 7 Surface water and groundwater monitoring, including the installation of additional monitoring wells; installation of an alternate water supply system; groundwater extraction; groundwater treatment by carbon adsorption; discharge of treated water by reinjection; excavation, treatment and disposal of contaminated sediments.

Tables ES-1, ES-2 and ES-3 provide summaries of the cost evaluation performed for the RAAs developed for the Berks Sand Pit Site.

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Table ES-1

BERKS SAND PIT SITE
REMEDIAL ACTION ALTERNATIVES
COST SUMMARY(1)
($1,000)

RAA No.	Capital Cost	Annual O&M Cost	Present Worth O&M Cost	Present Worth Cost		
				Lowest	Original	Highest
1	0	95.7	902.6	669.0	902.6	1,352.2
2	845.8	154.2	1,453.2	1,539.6	2,299.0	4,151.3
3	1,997.1	209 3	1,972.6	2,712.0	3,969.7	7,003.3
4	5,051.3	846.1	7,975.9	9,991.3	13,027.2	20,454 2
5	4,936.4	932 2	8,787.5	10,612.0	13,723.9	20,689.2
6	5,946.7	861.3	8,119.5	10,756.3	14,066.2	22,236.8
7	5,831 7	947.4	8,931.1	11,377.0	14,762.9	22,471.8

(1)All costs are presented in 1988 dollars.

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Table ES-2

BERKS SAND PIT SITE
COST COMPARISON OF ALTERNATE WATER SUPPLY SYSTEM OPTIONS[1]
($1,000)

Cost	New Well Field[2]	Extend Topton Water Supply System	Extend Mt. Village Trailer Park Water Supply System
Total Capital	151.3	1,217.0	699.0
Annual O&M	55.1	0	0
Present Worth O&M	519.4	0	0
Total Present Worth	1,607.7	1,217.0	699.0

(1) All costs in 1988 dollars.
(2) The new well field option of the alternate water supply system is used in the development of costs for Remedial Action Alternatives No. 3 through No. 7.

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Table ES-3

BERKS SAND PIT SITE
COST COMPARISON OF TREATMENT SYSTEM OPTIONS[1]
($1,000)

Cost	Treatment Options					
	A Air Stripping	B Vapor-Phase Carbon Adsorption[3]	C Liquid-Phase Carbon Adsorption[3]	Air Stripping with Vapor-Phase Carbon Adsorption[2] A + B	Air Stripping with Liquid- and Vapor-Phase Carbon Adsorption A + B + C	Liquid-Phase Carbon Adsorption[4]
Total Capital	902.3	259.6	599.9	1,161.9	1,761.8	920.4
Annual O&M	104 4	320.5	94.5	424 9	519.4	508.3
Present Worth O&M	984.1	3,021.7	890.5	4,005.8	4,896.3	4,791.7
Total Present Worth	1,886.4	3,281.4	1,490 4	5,167.7	6,658.1	5,712.1

(1) All costs in 1988 dollars.
(2) Air stripping with vapor-phase carbon adsorption included in RAA No. 4 and RAA No. 6.
(3) Liquid- and vapor phase carbon adsorption are secondary treatment options.
(4) Liquid-phase carbon adsorption is used as a primary treatment option in RAA No 5 and RAA No 7.

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INTRODUCTION

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1.0 INTRODUCTION

The Feasibility Study (FS) process is intended to develop and evaluate a wide range of Remedial Action Alternatives (RAAs) based on data obtained during the Remedial Investigation (RI) and from local, state, and federal agencies for sites listed on the National Priorities List (NPL). The FS presents the decision makers with necessary information to determine a course of action to remediate an NPL site under the guidance and direction of the National Oil and Hazardous Substances Contingency Plan of 1982 (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), The methodology for preparation of this FS for the Berks Sand Pit Site parallels the procedures outlined in the USEPA Guidance Document titled, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, October 1987), the NCP, and subsequent guidance as a result of the Superfund Amendments and Reauthorization Act of 1986 (SARA). The guidance documents and this FS use a multi-step screening process that begins with the presentation of general and specific site data.

1.1 Purpose

The FS is prepared in order to identify potential remedial technologies, which, after undergoing a screening process, are further developed into remedial action alternatives that also are subject to screening based on information obtained during the RI. The screening process subjects each technology and alternative to a consistent list of evaluation criteria that are selected in order to objectively assess the performance of each of the alternatives.

1.2 Site Description

The Berks Sand Pit site is located in Longswamp Township, Berks County, Pennsylvania (Figure 1-1). The site is approximately 15 miles northeast of Reading, near the Village of Huffs Church. A review of area geologic mapping reveals the site to be located within the Reading Prong Section of the New England Physiographic Province. The Reading Prong is characterized by Precambrian crystalline bedrock of several lithologies.

The Berks Sand Pit originally was created by the removal of sand and gravel from the area. The pit, which reportedly was used by area residents for refuse disposal, was approximately 100 feet in diameter and 30 feet deep. Industrial waste also was alleged to have been disposed of in the immediate vicinity of this site. Houses were constructed and private wells were

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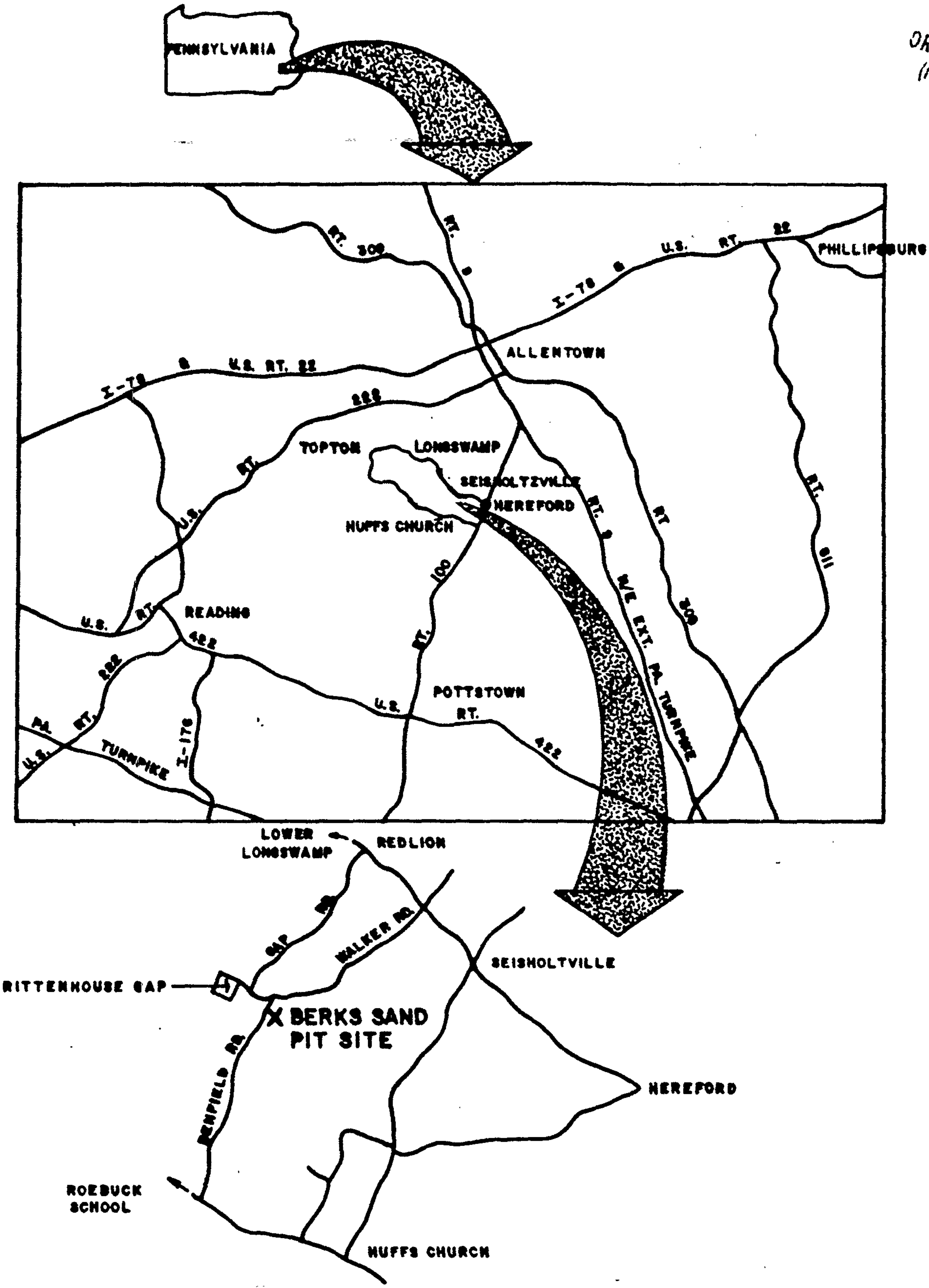

FIGURE 1-1
BERKS SAND PIT SITE
PROJECT LOCATION MAP

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installed at this location beginning in 1978, after the pit was backfilled. During January 1982, groundwater contamination was detected in the area by the residents. Despite emergency actions taken by EPA, no soil contamination or source for the groundwater contamination was discovered even though the pit was partially excavated and backfilled with clean fill (Figure 1-2). Groundwater contamination persists to this day, as indicated by elevated levels of organic compounds such as 1,1,1-trichloroethane (TCA) and 1,1-dichloroethene (DCE). The predominant organic contaminant at the site is 1,1,1-trichloroethane and has been selected as an indicator of the relative concentrations of other organics at the site.

1.3 Site History

Rittenhouse Gap, located approximately one-fourth of a mile northwest of the site, has been extensively mined for magnetite iron ore and is believed to be one of the oldest ore-producing districts in Berks County. The now abandoned iron mines consisted of open cuts, tunnels, and shafts. The cuts are generally elongated northeastward following the strike of the ore body while shafts and tunnels dip steeply southeastward. The Cha Gery mine shaft is located approximately 1,200 feet to the west of the RW-3 property (see Drawing 1).

Residents reported observing tank trucks traveling Benfield Road between September and November 1981, and that shortly thereafter, in early 1982, their well water had a distinguishable obnoxious odor and taste. Laboratory analysis conducted by PADER indicated that the following chemicals were detected in the R-3 residential well (RW-3):

1,1,1-Trichloroethane	> 45,000 µg/l
1,1-Dichloroethene	> 800 µg/l
1,1-Dichloroethane	> 300 µg/l
Dichloromethane	> 300 µg/l
1,2-Dichloroethane	> 150 µg/l
Toluene	> 150 µg/l

The EPA conducted a cleanup effort on the R-3 property during the summer of 1983. Activities consisted of excavating the area reported to be the sand pit, and installing a water supply well for four families whose wells were contaminated by the previous disposal operations. The excavation did not encounter any buried drums or other objects relating to the contamination.

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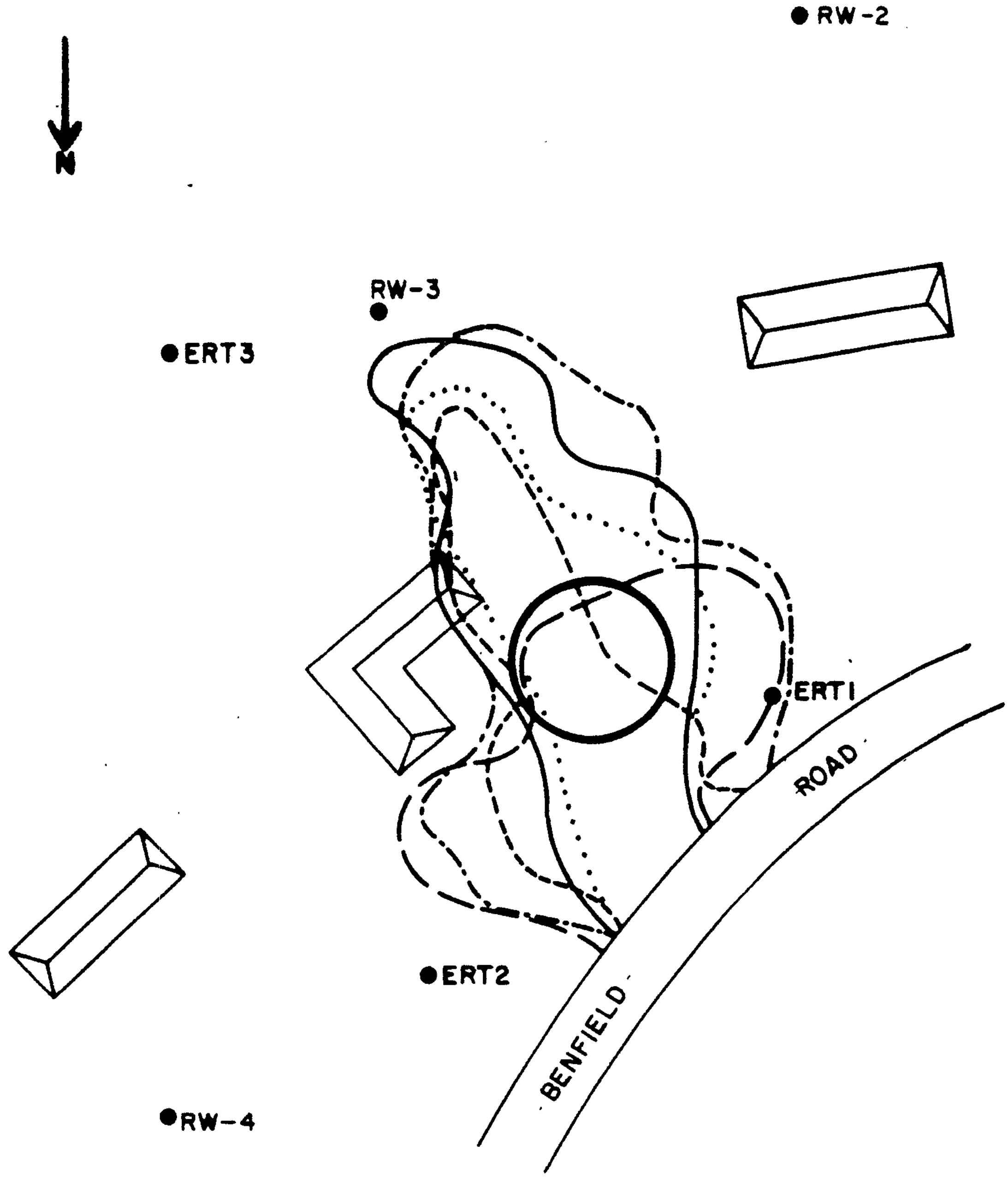

WELL LOCATION ●

MAGNETIC ANOMALY AND INFERRED EXCAVATED AREA ———

SAND PIT BOUNDARY

1971 ....

1958 - - - - -

1955 — —

BERKS SAND PIT

1955 – 1971

U.S. EPA ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER

APPROX. SCALE : 1" = 60'

FIGURE 1-2

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1.4 Remedial Investigation Summary

1.4.1 Site Activities

Three sampling events were performed during the RI phase in order to obtain environmental media samples to estimate the extent of contamination in the air, soil, surface water and sediments, and groundwater.

The first sampling event occurred in May 1987 for the purpose of performing a site reconnaissance, conducting a soil gas survey, and obtaining groundwater samples.

The second sampling event followed in the Fall of 1987 to obtain soil samples from a reported "hot spot", (encountered as a result of the soil gas survey) and to collect surface and groundwater samples from recently installed monitoring wells. Specially designed "packer tests" were performed in order to sample groundwater at discrete bedrock aquifer intervals and estimate the hydraulic conductivity of the bedrock at various depths in the monitoring wells.

A third round of sampling occurred during the Winter of 1988. This last round included sampling of all media and conducting a geophysical investigation to estimate the nature and direction of the fractures within the bedrock.

1.4.2 Site Activities Summary

The first step in the Remedial Investigation consisted of collecting and reviewing pertinent data from federal, state, and local agencies including the U. S. Environmental Protection Agency (EPA), PADER, and various Berks County agencies. After the site access was obtained, a detailed site reconnaissance was performed to familiarize personnel with the site, locate potential hazards, identify key physical features, sample residential wells, and conduct a soil gas survey to locate possible soil contamination.

A site operations manual was developed that outlined the methods to be followed to gather environmental data (air, surface water, sediments, subsurface soils, and groundwater), along with a site-specific Health and Safety Plan to be followed during the course of field activities, a Contingency Plan, a Contaminated Materials Handling Plan, and a Quality Assurance/Quality Control Plan.

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Following these preliminary activities, an extensive field sampling investigation was conducted. The sampling was performed to: 1) estimate the areal extent of contamination, 2) analyze samples for groundwater quality, 3) provide additional subsurface information, and 4) evaluate surface water and local well water quality off site. On-site activities included air monitoring; surface and borehole geophysical surveys; aquifer pump tests; and sampling of surface waters and sediments, local residential water supplies, subsurface soils, and groundwater from the shallow and deep installed monitoring wells. A second round of groundwater sampling and composite samples of RI-generated wastes also were obtained. Ancillary field activities employed for the RI included site surveying and mapping to prepare a current map of the site, and air monitoring to select levels of respiratory protection requirements for the site. Highlighted below are the significant dates and events that pertain to the Berks Sand Pit Site field investigation.

Based on the site reconnaissance and discussions with PADER, the sampling locations (shown on Drawing 1) were chosen to provide the information necessary to characterize the site conditions. The following is a list of the sampling activities performed during the Remedial Investigation:

Spring 1987 - Site Reconnaissance

1. Air Quality Monitoring
2. Soil Gas Survey
3. Residential Well Sampling

Fall 1987 - First Sampling Round

1. Air Quality Monitoring
2. Surface Water and Sediment Sampling
3. Subsurface Soil Sampling
4. Groundwater Monitoring Well Sampling (Deep)

Winter 1988 - Second Sampling Round

1. Air Quality Monitoring
2. Surface Water Sampling
3. Groundwater Monitoring Well Sampling (Deep)
4. Groundwater Monitoring Well Sampling (Shallow)
5. Residential Well Sampling
6. Water Supply Well Sampling

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The specific sampling and quality control procedures followed during the RI field investigation are contained in the Operations Plan.

Due to the possibility of encountering hazardous conditions, safety procedures were developed and enforced through the implementation of a site Health and Safety Plan (HASP). The HASP was followed throughout the performance of on-site activities. A briefing was given to the on-site personnel regarding the possible hazardous contaminants that could be encountered, personal protection available, location of nearest phone and first aid kit, and directions to the nearest hospital. In case of an emergency, phone numbers and directions to the nearest hospital were posted at all times in the project trailer. The Site Health and Safety Officer was charged with the responsibility of enforcing the HASP during the field program.

The level of personal protection incorporated at the site was determined to be Level D (the lowest level of protection) for initiation of all field activities. Standard issue steel-toed boots, hard hats, and safety glasses were worn throughout the drilling operations. Other safety equipment such as rubber overboots, Tyvek® coveralls, nitrile gloves, and cartridge respirators were kept in the project trailer and worn when deemed necessary by the On-Site Coordinator and Site Health and Safety Officer. Periodic direct readout air monitoring for organic vapors was conducted in addition to performing quantitative air sampling for both organics and metals at specified intervals in order to verify respiratory protection requirements.

1.4.3 Remedial Investigation Summary

Based on the results of the RI Report, the Berks Sand Pit Site's groundwater has a significant potential adverse health impact on receptor populations as calculated by the chronic health index and the risk-from-potential carcinogens indices. There were two complete exposure pathways identified: 1) the groundwater exposure pathway via inhalation, ingestion, and dermal contact by receptors on residential wells, and 2) the surface water/sediment exposure pathway via ingestion and dermal contact.

The air pathway was not noted as a health hazard with regard to the volatilization of organics from the surface waters or from the surface soils. However, inhalation of volatile organics was considered to be a potential health hazard from the groundwater exposure pathway. In addition, the surface soils do not appear to be a health hazard from dermal contact or ingestion exposure routes.

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The groundwater exposure pathway had significant chronic hazard index values and projected risk values above the target risk values for carcinogens. The compounds most responsible for the potential adverse health impacts were 1,1-dichloroethene, and 1,1,1-trichloroethane. The residential wells having levels of these two compounds of concern were RW-2, RW-3, RW-4, and RW-7. Groundwater samples from the on-site monitoring wells also showed concentrations capable of having a potential adverse health effect if ingested. The migration of the groundwater plume, generally toward the east, could elevate concentrations found in the groundwater from monitoring wells and to human receptors using their residential wells as a source of potable water.

The surface water and sediment exposure pathway had significant chronic health index values for non-carcinogens and projected risks values above the target risk values for carcinogens. The same compounds found in the groundwater exposure pathway, 1,1-dichloroethene and 1,1,1-trichloroethane, also presented a significant potential adverse health impact for ingestion and dermal contact of surface waters and sediments. The sediment samples SP-1 through SP-8 are directly in line with the migrating groundwater plume and further define the extent of contamination. The surface water and sediment samples indicate the potential concentrations of contaminants to receptors using these areas (e.g., small children), and to the receptors who are using groundwater in the area.

1.4.4 Extent of Contamination

The primary contamination at the Berks Sand Pit Site occurs in the groundwater. There are four volatile organic chemicals of concern -- 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), 1,1-dichloroethene (DCE) and tetrachloroethene (PCE) -- although only two, TCA and DCE will be addressed in this FS report (refer to Section 2.2.1). A review of historical data indicates that although the contamination at the site has decreased somewhat (due to groundwater migration and dilution) over the past five years (1983 to 1988), it is still present in measurable quantities. Historical data, as well as the data gathered during this investigation, show some large fluctuations in contaminant concentrations over relatively short (months) periods of time.

Drawings 4 through 7 in Volume I of the Remedial Investigation Report illustrate the current estimated extent of TCA and DCE in the groundwater. As can be seen from these maps, the upgradient extent of groundwater contamination is present beneath the R-2 property. The

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highest concentrations of TCA and DCE appear to extend downgradient (east-northeast) in a narrow plume at least as far as the headwaters of a tributary to the West Branch of Perkiomen Creek (i.e., at least 1000 feet east-northeast from MW-7). The highest concentrations of TCA and DCE occur along the plume axis, MW-7 to MW-4 and SW-2 to SP-1, with the maximum concentrations centered about MW-4.

Lower levels of contamination appear to extend north and northwest of this axis towards Benfield and Walker Roads. The area of groundwater contamination (high and low) potentially includes residents served by residential water wells RW-2 through RW-12. The eastern extent of the groundwater plume has not been completely defined and may extend beyond the study area.

The vertical extent of the contamination was investigated during the packer tests. It appears that there is a vertical variation in concentration of both TCA and DCE. The bottom of the plume, however, has not been completely defined by the packer tests. One packer test sample indicated contamination at a depth of about 250 feet below the surface. Data from the geophysical investigations also were used to estimate the depth of contamination. These investigations showed major water bearing zones to a depth of 250 feet to 300 feet below the surface. These data suggest either sinking of high concentrations of contaminants or vertical, downward hydraulic gradients transporting contaminated groundwater deep into the fractured bedrock aquifer.

1.5 Remedial Action Goals

The overall purpose of the FS process is to develop and provide a range of technically sound, cost-effective remedial action alternatives to control the contaminant source and to manage the migration of contaminants, in order to provide protection to public health, welfare, and the environment. The major potential threat to public health and the environment identified as a result of conducting the RI is through the introduction into the groundwater of organic contaminants, primarily DCE and TCA, associated with an unknown quantity of disposed liquid wastes. Another exposure pathway exists through the introduction of contaminants through groundwater discharging to the surface in various springs and seeps.

To achieve the purposes of the FS process and to address the current and potential future threats posed by the site, the following range of cleanup goals were identified:

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1. Maintain current potential risk level by not implementing any remedial action (no action).

2. Reduce a possible increase in the current or future potential risk at the site by containing the waste or minimizing the migration of the groundwater plume.

3. Reduce the current and future potential risk from groundwater contamination with alternatives that attain applicable or relevant and appropriate requirements (ARARs) for human health.

4. Reduce the current and future potential risk from groundwater contamination to background levels (no risk) by eliminating the source of the waste material through the use of alternatives that attain ARARs for both human health and the environment.

Potential technologies have been identified and are presented herein. These technologies were screened against criteria to determine their applicability. Those remaining were combined to form remedial action alternatives. The remedial action alternatives then were evaluated for their ability to achieve the previously mentioned cleanup goals with respect to source control and management of migration. Cleanup goal No. 1 does not address control of the contaminant source or provide management of source migration. Cleanup goals Nos. 2, 3, and 4 address, to varying degrees, the management of migration due to the nature of the wastes (liquid), and the alleged disposal method (surface dumping); source control is not a feasible cleanup goal.

An evaluation of each of the pathways and potential receptors identified in the RI, with respect to the previously mentioned goals, is discussed in the following paragraphs.

1.5.1 Air

Because no current or future potential risk to human health or the environment currently exists via this pathway, as evidenced by air sampling and analysis conducted during the RI, remedial actions that address air quality are not necessary and will not be considered for this site.

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1.5.2 Soil

Because no current or future potential risk to human health or the environment exists via this pathway, as evidenced by soil sampling and analysis conducted during the RI, remedial actions that address soil contamination are not necessary and will not be considered for this site.

1.5.3 Groundwater

Groundwater contamination is considered the greatest potential threat to human health at the Berks Sand Pit Site. This is based on the presence of TCA and DCE at concentrations that present a health risk to the residents who may come in contact with this water through ingestion or inhalation. Therefore, remedial actions that achieve the full range of cleanup goals will be considered and evaluated as applicable and appropriate.

1.5.4 Surface Water and Sediments

The surface water and sediment exposure pathway is considered to be a significant potential threat to human health and the environment. This is based on the presence of DCE at concentrations that present a risk to receptors through a dermal and oral exposure pathway. Therefore, remedial actions that achieve the full range of cleanup goals will be considered and evaluated as applicable and appropriate.

1.6 Feasibility Study Procedure

The FS process is intended to develop and evaluate remedial action alternatives for the site using data obtained from the RI in addition to other site-related information obtained from local, state, and federal agencies.

The methodology for preparation of this FS parallels the procedure outlined in the EPA Guidance Document and the NCP. This procedure includes the following three tasks:

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- Identification of General Response Actions

  The EPA Guidance Document provides a comprehensive listing of General Response Actions (GRAs) and associated remedial technologies. The GRAs identified in the Guidance Document are listed in Table 1-1.

- Identification and Screening of Technologies

  The technologies associated with the identified GRAs were screened on the basis of site conditions and nature of site contaminants to determine their suitability for inclusion in development of remedial action alternatives. A detailed explanation of this screening process and the results of the technology screening are presented in Section 2.0 of this report.

- Development of Remedial Action Alternatives

  RAAs were developed from the technologies screening in Section 2.0. Alternatives judged to have significant adverse impacts, or that were judged to be substantially higher in cost without providing greater benefit, were not considered further. These RAAs are discussed in Section 3.0 of this FS report.

  Section 4.0 describes each alternative in detail and discusses the results of the alternative screening process. Section 5.0 discusses the results of the detailed evaluation process. The RAAs evaluated in Section 5.0 are summarized in Section 6.0 to facilitate review and selection of the appropriate remedial action for the Berks Sand Pit Site by PADER and USEPA.

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Table 1-1

GENERAL RESPONSE ACTIONS

No Action

Institutional Actions

Containment

Collection

Treatment

Discharge/Disposal

Alternative Water Supply

Relocation

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TECHNOLOGIES

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2.0 SCREENING OF GENERAL RESPONSE ACTIONS AND ASSOCIATED TECHNOLOGIES

2.1 Introduction

In this section, the general response actions (GRAs) previously presented in Section 1 0 are evaluated along with their associated technologies to screen inappropriate technologies from further consideration. The GRAs and associated technologies for specific media are listed in Tables 2-1 through 2-3.

2.2 General Response Action Objectives

General response actions are medium (soil, water, air) specific actions, each of which may include several technology types, that may be undertaken to meet the remedial action objectives. A list of general response actions are given in Tables 2-1, 2-2, and 2-3. Each GRA may contain one or more technology types or general technology categories. In turn, each technology type may contain one or more technology processes that may be applicable to meeting the remedial action objectives.

2.2.1 Contaminants of Concern

The contaminants of concern at the Berks Sand Pit Site are predominantly volatile organic compounds (VOCs). Specifically, four VOCs were identified as contaminants of concern in the risk assessment portion of the Remedial Investigation (RI) Report 1,1,1-trichloroethane (TCA), 1,1-dichloroethene (DCE), 1,1-dichloroethane (DCA), and tetrachloroethene Two of these contaminants, TCA and DCE, are particularly pervasive throughout the site and are the compounds that are addressed in this Feasibility Study (FS). Other constituents at the site, such as iron, may need to be addressed for some treatment processes.

2.2.2 Target Contaminant Levels

The objectives of the general response actions are to reduce contaminant concentrations to some predetermined target level and to reduce potential exposure pathways. Target cleanup levels have been developed based on applicable or relevant and appropriate requirements (ARARs) and PADER/EPA direction for the two indicator contaminants. The target contaminant levels, based on National Primary Drinking Water Standards (NPDWS)

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Table 2-1

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR GROUNDWATER

General Response Action	Technology Type	Technology Process	Description	Comments
No Action	None	Not Applicable	No Action.	Required for consideration by NCP.
Institutional Actions	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence would include well restrictions.	Potentially applicable.
	Alternate Water Supply	Expand Existing System	Expand Mt. Village Trailer Park or Topton water supply systems.	Potentially applicable.
		New Well	Drill new water supply well.	Potentially applicable.
	Monitoring	GW Monitoring	Periodic monitoring of wells.	Potentially applicable.
	Relocation	Not Applicable	Relocation of public.	Not applicable; no immediate danger of life and health.
Collection	Extraction	Extraction	Wells to extract contaminated groundwater.	Potentially applicable.
		Extraction/ Injection Wells	Injection wells inject uncontaminated water to increase extraction well flow.	Potentially applicable.
	Subsurface Drains	Interceptor Trenches	Trenches backfilled with porous material to collect groundwater.	Not effective - contamination too deep.
		French Drains	Peforated pipe in gravel-filled beds.	Not effective - contamination too deep.
Discharge	On-site Discharge	Local Stream	Extracted water discharged to stream on site.	Potentially applicable after treatment of water.
		Injection Well	Extracted water discharged to deep well injection system.	Potentially applicable after treatment of water.
		Diffuse Discharge	Extracted water discharged to land surface.	Not acceptable; requires large land areas.
	Off site Discharge	POTW	Extracted water discharged to local POTW for treatment.	No local POTW.

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Table 2-1

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR GROUNDWATER (continued)

General Response Action	Technology Type	Technology Process	Description	Comments
Containment	Cap	Clay and Soil	Compacted clay covered with soil over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source.
		Asphalt	Spray application of a layer of asphalt over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source
		Concrete	Installation of a concrete slab over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source.
		Multi-media Cap	Clay and synthetic membrane covered by soil over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source.
	Vertical Barrier	Slurry Wall	Trench around areas of contamination filled with soil (or cement)/bentonite slurry.	Not feasible because of the shallow depth to bedrock, depth of contamination.
		Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes.	Not effective because of fractured bedrock, depth of contamination.
		Vibrating Beam	Vibrating force to advance beams into ground, injection of slurry as beam is withdrawn.	Not feasible because of the shallow depth to bedrock, depth of contamination.
		Sheet Piling	Vertical piles driven into ground.	Not feasible because of the shallow depth to bedrock, depth of contamination.
	Horizontal Barrier	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes.	Not effective because of irregularly fractured bedrock.
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes.	Not feasible because of shallow depth to bedrock, depth of contamination and irregularly fractured bedrock.

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ORIGINAL (Red)

Table 2-1

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR GROUNDWATER (continued)

General Response Action	Technology Type	Technology Process	Description	Comments
			See Collection under "Collection/Discharge" above.	
Collection / Treatment / Discharge	Biotreatment	Aerobic	Degradation of organics using microorganisms in an aerobic environment.	Not effective; aerobic biotreatment not applicable to halogenated wastes.
		Anaerobic	Degradation of organics using microorganisms in an anaerobic environment.	Not feasible; generally available only in POTWs.
	Physical Treatment	Stripping	Mixing large volumes of air with water in a packed column to remove contaminants.	Potentially acceptable.
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column.	Potentially acceptable.
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind.	Not feasible because the technology is not proven for chlorinated hydrocarbon contaminants.
		Distillation	Passing contaminated groundwater through distillation column to remove VOCs.	Not feasible because the contaminants are too dilute.
	Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer.	Not economical, liquid volume too large.
		Fluidized Bed	Waste injected into a hot, fluidized bed of sand where combustion occurs.	Not economical, liquid volume too large.
	Off-site Treatment	POTW	Extracted groundwater discharged to a local POTW for treatment.	No local POTW to discharge to.
		RCRA Facility	Extracted groundwater discharged to licensed RCRA facility.	Not acceptable.
	In Situ Treatment	Bioreclamation	System of injection and extraction wells introduce bacteria, nutrients to degrade contaminants.	Not feasible; injected nutrients may contaminate usable domestic wells.
		Aeration	System of wells to inject air into groundwater to remove volatiles by air stripping.	Not feasible because of fractured bedrock.
		Permeable Treatment Bed	Downgradient trenches backfilled with activated carbon to remove contaminants.	Not feasible because of shallow depth to bedrock, fractured bedrock, depth of contamination.
		Chemical Reaction	System of injection wells to inject oxidizer such as H_2O_2 to degrade contaminants.	Not feasible because of fractured bedrock.
	Chemical Treatment	Neutralization	Adjusting the pH of the groundwater to within the range of 5 to 9.	Not applicable because the pH of the groundwater lies between 5 and 9.
		Redox Treatment	The chemical transformation of reactants in which one reactant is oxidized and the other is reduced.	Not feasible for wastes containing high organics concentration or high water content.
		Ion Exchange/ Water Softening	Pretreatment of the groundwater for air stripping.	Potentially applicable
			See Discharge under "Collection/Discharge" above.	

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Table 2-2

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR SURFACE WATER

General Response Action	Technology Type	Technology Process	Description	Comments
No Action	None	Not Applicable	No Action	Required for consideration by NCP.
Institutional Actions	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence, would include well restrictions.	Potentially applicable.
	Monitoring	Surface Water Monitoring	Periodic surface water monitoring.	Potentially applicable.
	Alternate Water Supply	Expand Existing System	Expand Mt. Village Trailer Park or Topton water supply systems.	Not applicable; suface water not used as a water supply source.
		New System	Develop a new water supply system.	Not applicable; surface water not used as a water supply source
	Relocation	Not Applicable	Relocation of public.	Not applicable; not immediately dangerous to life and health.
Collection	Surface Controls	Grading	Change surface water runoff patterns through grading.	Not applicable; surface water is fed by groundwater source.
		Diversion	Surface water diversion, rerouting around site.	Not applicable; surface water is fed by groundwater source.
		Collection	Impounded surface water collected.	Potentially applicable.
Discharg	On-site Discharge	Local Stream	Surface water discharge back to stream.	Potentially applicable after treatment of water.
		Injection Well	Surface water discharge to deep injection well.	Potentially applicable after treatment of water.
		Diffuse Discharge	Surface water discharged to land surface.	Not acceptable; requires large land area.
	Off-site Discharge	POTW	Collected water discharged to local POTW for treatment.	No local POTW.
		RCRA	Co[illegible]ted water discharged to a R[illegible] facility for treatment.	Not applicable because [illegible]nd ban.

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ORIGINAL (Red)

Table 2-2

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR SURFACE WATER (continued)

General Response Action	Technology Type	Technology Process	Description	Comments
Collection			See Collection under "Collection/Discharge" above.	
Treatment	Biotreatment	Aerobic	Degradation of organics using microorganisms an aerobic environment.	Not effective; aerobic biotreatment not applicable to halogenated wastes.
		Anaerobic	Degradation of organics using microorganisms in an anaerobic environment	Not feasible; generally available only in POTWs.
	Physical Treatment	Stripping	Mixing large volumes of air with water in a packed column to remove contaminants.	Potentially acceptable.
		Carbon Adsorption	Adsorption of contaminants onto activated carbon.	Potentially acceptable.
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind.	Not effective because the technology is not proven for chlorinated hyrocarbon contaminants.
		Distillation	Passing contaminated surface water through a distillation column to remove VOCs.	Not effective because the contaminants are too dilute.
	Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer.	Not economical, liquid volume too large.
		Fluidized Bed	Waste injected into a hot, fluidized bed of sand where combustion occurs.	Not economical, liquid volume too large.
	Off-site Treatment	POTW	Collected surface water discharged to a local POTW for treatment.	No local POTW.
		RCRA Facility	Collected surface water discharged to licensed RCRA facility.	Not acceptable.
	In Situ Treatment	Bioreclamation	Add nutrients and bacteria to degrade contaminants.	Not feasible; injected nutrients may further contaminate surface water.
		Aeration	Passing the water over a weir to reduce VOC content.	Not effective.
		Chemical Reaction	Addition of chemicals, such as H_2O_2 to degrade contaminants.	Not feasible; added chemicals may further contaminate stream.
	Chemical Treatment	Neutralization	Adjusting the pH of the surface water to within the range of 5 to 9.	Not applicable because the pH of the surface water lies between 5 and 9.
		Redox Treatment	The chemical transformation of reactants in which one reactant is oxidized and the other is reduced.	Not feasible for wastes containing high organics concentration or high water content.
		Ion Exchange/ Water Softening	Pretreatment of the groundwater for air stripping.	Potentially applicable.
Discharge			See Discharge under "Collection/Discharge" above.	

ORIGINAL (Red)

AR300808

Table 2-3

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR SEDIMENTS

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No Action.	Required for consideration by NCP
Institutional Actions	Access Restrictions	Deed Restrictions	Deeds for property in the area would include restrictions on the use of contaminated areas.	Potentially applicable.
	Monitoring	Sediment Monitoring	Ongoing monitoring of sediments.	Potentially applicable.
	Relocation	Not Applicable	Relocate public.	Not applicable; not immediately dangerous to life and health.
Collection	Sedimentation	Sedimentation	A gravity settling process that allows for the separation of heavier solids and the resulting supernatant.	Not applicable.
	Excavation	Excavation	Excavation of contaminated sediments.	Potentially applicable.
Disposal	Off-site Disposal	Off-site Landfill	Shipment of waste (sediment) to an approved landfill.	Potentiall applicable after treat-ment.
	On-site Disposal	On-site Landfill	Construction of landfill of suitable design.	Not feasible because of location in residential area

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ORIGINAL (Red)

Table 2-3

SUMMARY OF GENERAL ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR SEDIMENTS - continued-

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Containment	Cap	Clay and Soil	Compacted clay covered with soil over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source
		Asphalt	Spray application of a layer of asphalt over contaminated areas.	Not feasible because of the large site area, residential structures; no well defined source
		Concrete	Installation of a concrete slab over areas of contamination.	Not feasible because of the large site area, residential structures; no well defined source
		Multi-Media Cap	Clay and synthetic membrane covered by soil over contaminated areas.	Not feasible because of the large site area, residential structures; no well defined source.
	Vertical Barriers	Slurry Wall	Trench around areas of contamination is filled with a soil (or cement)/bentonite slurry.	Not feasible because of shallow depth to bedrock, depth of contamination, no well defined source.
		Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes.	Not effective because of shallow depth to bedrock, depth of contamination, no well defined surce.
		Vibrating Beam	Vibrating force to advance beams into the ground with injection of slurry as the beam is withdrawn.	Not feasible because of shallow depth to bedrock, depth of contamination, no well defined source.
	Horizontal Barriers	Grout Injection	Pressure injection of grout at depth through closely-spaced drilled holes.	Not effective because of fractured bedrock, no well defined source.
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes.	Not feasible because of shallow depth to bedrock, depth of contamination and fractured bedrock and no well defined source.
	Sediment Control Barrier	Cofferdams	A series of cofferdams across a stream or river to allow sediment settling.	Not applicable, flow of the seep associated with the sediment is too low.
		Curtain Barriers	A curtain barrier across a stream or river to allow sediment settling.	Not applicable, flow of the seep associated with the sediment is too low.

AR300810

ORIGINAL (Red)

Table 2-3

SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND PROCESSES FOR SEDIMENTS - continued-

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Collection	Sedimentation	Sedimentation	A gravity settling process that allows for the separation of heavier solids and the resulting supernatant.	Not applicable.
Collection	Excavation	Excavation	Excavation of contaminated sediments.	Potentially applicable.
Treatment	Solidification Fixation Stabilization	Sorption	Contaminants are bound-up in pozzolan-type matrices by physical sorption or chemical sorption.	Not applicable.
		Pozzolanic Agents	Sediments are treated by the addition of large amounts of siliceous materials combined with a settling agent.	Not applicable.
		Encapsulation	Mixing of the heated, dried sediment with asphalt bitumen, parrifin, or polyethylene.	Not applicable to wastes with high water content or containing volatiles.
	Chemical Treatment	Neutralization	Adjusting the pH of the sediment to within the range of 5 to 9.	Not applicable because the pH of the soil lies between 5 and 9.
		Redox Treatment	The chemical transformation of reactants in which reactant is oxidized and the other is reduced.	Not feasible for wastes containing high organics concentration or high water content.
	In Situ Treatment	Soil Flushing/ Soil Washing	Passing extractant solvents through an injection/ recirculation process.	Not feasible because of potential contamination from extractant solvents.
		Surface Bioreclamation	Bacteria and nutrients are added to the soil in order to degrade the contaminants.	Not feasible because the biodegradation is inhibited by halogenated hydrocarbons (such as TCA, DCE).
	Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer.	Potentially applicable for off-site treatment; not economical for on-site treatment
		Fluidized Bed	Waste injected into hot agitated bed of sand where combustion occurs.	Potentially applicable for off-site treatment; not economical for on-site treatment
		Pyrolysis	Chemical decomposition of contaminants through heating in the absence of oxygen.	Potentially applicable for off-site treatment; not economical for on-site treatment
Disposal	Off-site Disposal	RCRA Facility	Shipment of waste (sediment) to an approved landfill.	Potentially applicable if treated prior to disposal.
	On site Disposal	On site Landfill	Construction o[illegible]dfill of suitable design	Not feasible because of lo[illegible] in residential area

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AR300811

ORIGINAL (Red)

maximum contaminant levels (MCL) are 200 µg/l for TCA and 7 µg/l for DCE. These target contaminant levels will be considered to be acceptable cleanup levels, although ideally, cleanup to background contaminant levels is desirable.

2.3 Identification of Remedial Technology Types and Processes

For each GRA, there are one or more technology types or general technology categories. The technology types for each GRA will be identified and screened in the following sections.

For each technology type there are one or more specific technology processes that may be applicable to remedial actions at the Berks Sand Pit Site. The result of the screening process will be a set of applicable, representative technology processes that will be combined into remedial action alternatives for further evaluation. Tables 2-1, 2-2, and 2-3 list some specific technology types for various environmental media.

2.4 Technology Screening Procedure

Technologies will be screened by considering the types of general technologies, and then proceeding to more specific processes within each type. The GRAs will be screened first, followed by a screening of the technology types. The technology processes in each applicable technology category will be screened last. The result of these screenings will be a list of technology processes that may be applicable to remedial actions at the site. These technology types will be combined into remedial action alternatives in Section 3.0.

These screening procedures will use three criteria to evaluate the technologies: implementability or feasibility, effectiveness or applicability, and cost. A more detailed evaluation of the technology processes in the remedial action alternatives (RAAs) is provided in Section 5.0.

2.5 No Action

This GRA would retain the site in its current condition to provide a baseline against which the relative effectiveness of other remedial actions may be compared.

Some monitoring and analysis can be performed to provide a mechanism for determining trends, if any, of contaminant concentrations and migration from the site. A no action

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response is considered feasible for further evaluation, and is required for consideration by the National Oil and Hazardous Substances Contingency Plan of 1982 (NCP)

2.6 Institutional Actions

Institutional GRAs include imposing access restrictions on site and monitoring of the contaminants at the site. Access restrictions encompass actions such as fencing off the site or developing deed restrictions. Monitoring includes sampling and analysis of surface water and groundwater and, if necessary, expansion of the monitoring system to track contaminant movement. Development of an alternate water supply system and relocation of residents are also institutional actions; because of their extent, these will be discussed under separate headings below (Sections 2.7 and 2.8 respectively). The institutional actions of monitoring and deed restrictions are considered feasible for further evaluation

2.7 Alternate Water Supply

Provision for an alternate water supply is necessary when central water supplies become contaminated at the source or in transmission. Replacement of water supplies may involve the following:

- Purchase of water from another supply
- Provision of a new surface water intake(s)
- Provision of a new groundwater well(s)
- Connection to or extension of a new distribution line or system
- Purchase of bottled and bulk water
- Installation of point-of-use wells
- Collection of rainwater

There are numerous residential wells at the Berks Sand Pit Site that exhibit elevated concentrations of volatile organic compounds An alternate water supply will be retained for further evaluation.

2.8 Relocation

Relocation, as a general response action, is necessary when a site or remedial action poses an immediate risk to human health. Residents are moved from their homes either temporarily or permanently.

The Berks Sand Pit Site does not pose an immediate threat to life and health. Relocation is not warranted and will not be considered further.

2.9 Containment

This action involves leaving the waste in place and applying technologies for minimizing the migration of contaminants. Some technologies included in this GRA are surface capping and impermeable groundwater barriers.

2.9.1 Surface Capping

Surface capping has been effectively utilized in industry and in the management of uncontrolled hazardous waste sites to control the contaminant migration mechanisms of infiltration and stormwater run-off.

Available materials for surface capping include geomembranes, low permeability soil (clays, silty clays, clayey silts, and selected silts), local or on-site soil materials, asphalt materials, chemical stabilizers, or multimedia caps constructed of geomembrane and low permeability soil layers.

Surface capping is not considered a feasible technology for application at this site and will not be further evaluated because:

- There is no well-defined source of contamination that may be capped; and
- Capping will not hinder the movement of fluids in the fractured bedrock aquifer beneath the site.

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ORIGINAL (Red)

2.9.2 Impermeable Barriers

Impermeable barriers can be used to divert groundwater flow around a waste disposal area or to contain contaminated groundwater or soils. Such barriers can be placed upgradient of a site, downgradient of a site, or completely surrounding a site. Various methods and types of vertical and horizontal impermeable barriers include:

Vertical Barriers

- Slurry walls
  - soil/bentonite
  - cement/bentonite
- Sheet piling
- Grout curtain
- Vibrating beam

Horizontal Barriers

- Grout injection
- Block displacement

This technology category is not considered feasible for application at this site because:

- The local hydrogeologic conditions are quite complex and the effectiveness of barriers cannot be assured.
- The depth of contamination would make the construction of both horizontal and vertical barriers difficult.
- There does not appear to be a lower confining layer, so vertical barriers will probably be ineffective.
- There is not a well defined source of contamination around which to place a barrier.

2.10 Collection

Collection is a GRA that includes the collection of contaminants in groundwater, surface water, and soils or sediments. The primary purpose of collection is to reduce potential exposure pathways.

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2.10.1 Groundwater Collection

2.10.1.1 Pumping: Extraction-Injection

Pumping is an active approach to site remediation, as compared to passive approaches of installing impermeable barriers.

Groundwater pumping has been successfully implemented to control contaminated groundwater beneath disposal sites. The term "pumping," as used here, refers to either removal of water from (extraction), or injection of water into an aquifer. Three main applications include:

- Pumping (extraction) to lower the water table, thereby minimizing direct contact with wastes.
- Pumping (extraction or injection) to contain a contaminant plume and extract contaminants.
- Pumping (extraction or injection) to reverse or influence direction of groundwater flow.

Groundwater contamination is the primary problem at the Berks Sand Pit Site. Therefore, groundwater pumping, either removal or injection, is applicable. This technology is considered to be feasible, and will be retained for further evaluation.

2.10.1.2 Subsurface Drains

- Interceptor Trenches

  Interceptor trenches are constructed downgradient from the contamination and backfilled with highly permeable material. The trenches tend to intercept and collect water so that it may be easily removed by pumping.

  It would be technically difficult and prohibitively expensive to construct trenches at this site due to the depth of contamination and the complex hydrology of the site. Therefore, this technology is eliminated from further evaluation.

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- French Drains

French drains are subsurface drains consisting of perforated pipe buried in gravel-filled trenches. The drains intercept leachate or infiltrating water destined to become leachate and transport it away from the site.

It will be difficult to construct subsurface drains at this site. In addition, their effectiveness will be questionable due to the complex site hydrogeology, large depth of contamination, and undefined source. This technology is screened from further consideration.

2.10.2 Surface Water Collection: Surface Controls

2.10.2.1 Diversion and Grading

Several well-established construction techniques are available for diverting and handling surface stormwater flow to hydrologically isolate waste disposal sites from surface inputs.

Based on the results of the Remedial Investigation, infiltration and leachate generation are not considered to be problems at this site. Therefore, these technologies are eliminated from further consideration.

2.10.2.2 Liquid Removal from Surface Impoundments (Collection)

This technology involves pumping of contaminated impounded surface liquids for removal and/or treatment. Based on field sampling during the Remedial Investigation (RI), there are no contaminated impounded surface liquids in the vicinity of the site. Therefore, this technology is not applicable and will not be considered further.

2.10.3 Soil Sediment Collection

2.10.3.1 Excavation

Excavation of contaminated soils and sediments is a common technique for remedial action at waste disposal sites. Mechanical means are used to remove contaminated materials for

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ORIGINAL (Red)

loading and transportation to an approved facility for treatment and disposal, and also for treatment and on-site disposal.

Excavation is a commonly used and well established technique involving standard construction practices. Typical equipment includes draglines, loaders, dozers, pans, trucks and backhoes. This technology is applicable to the removal of sediments in the vicinity of the site, and will be retained for further evaluation.

2.10.3.2 Dredging

Mechanical and hydraulic dredging equipment are used to remove contaminated sediments from surface water bodies. Because of the small volume of contaminated sediments in the vicinity of the site, dredging is not the most efficient or cost effective technology for sediment removal. Therefore, this technology will not be considered further.

2.10.3.3 Sedimentation

Sedimentation is a process that allows for the gravity separation of liquids from heavier solids in waste streams. Sedimentation can be carried out by either batch or continuous removal processes. Sediments at the site have already been separated from the liquids by natural sedimentation processes. Therefore, this technology will not be considered further.

2.11 Treatment

Included in this GRA are seven technologies: biotreatment, physical treatment, thermal treatment, off-site treatment facility, in-situ treatment, chemical treatment, and solidification/stabilization/fixation.

2.11.1 Biotreatment

Biotreatment utilizes microorganisms to degrade contaminants in either aerobic or anaerobic environments. Aerobic treatment is not an effective method for the degradation of halogenated wastes and will not be considered further. Anaerobic treatment may be effective in biodegrading organic wastes, but this treatment method is generally confined to POTWs and is not considered to be feasible at this site. Biotreatment is screened from further consideration.

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2.11.2 Physical Treatment

Four general physical treatment processes were considered for this FS for the treatment of contaminated ground and surface water: air stripping, liquid-phase carbon adsorption, reverse osmosis, and distillation.

Air stripping involves the mass transfer of contaminants in water into air through diffusion This technology has been demonstrated to be effective in treating water contaminated with volatile organics and will be retained for further evaluation.

Carbon adsorption involves passing contaminated water through granular activated carbon beds so that contaminants may adsorb onto the carbon. This is an effective technology for treating water contaminated with volatile organics and will be retained for further evaluation.

Reverse osmosis involves creating a concentrated waste stream by separating contaminants from the water across a semi-permeable membrane. Although this technology is effective, it is prohibitively expensive in comparison to air stripping and carbon adsorption. Therefore, reverse osmosis is screened from further consideration.

Distillation involves passing the contaminated liquid through a distillation column to separate contaminants from water based upon their various boiling points. The contaminated liquids at the Berks Sand Pit Site are too dilute for this technology to be economically feasible. Therefore, distillation will not be considered further.

2.11.3 Thermal Treatment

Thermal treatment of groundwater and sediments includes technologies such as rotary kiln or fluidized bed combustion. Although these technologies are proven and reliable for the destruction of concentrated organic contaminated liquid and solid wastes, these technologies would be ineffective for the treatment/destruction of the relatively dilute liquids found at the Berks Sand Pit Site. Therefore, thermal treatment is not considered applicable for the remediation of the groundwater for this site. This technology is being retained for further evaluation for the off-site treatment of sediments.

AR300819

One additional technology considered for the off-site thermal treatment of sediments is pyrolysis. This technology is the chemical decomposition of contaminants through heating in the absence of oxygen. This technology is being retained for further evaluation for the off site treatment of the sediments.

2.11.4 Off-Site Treatment

Off-site treatment employs removal of wastes and transport off-site to a POTW or a RCRA-approved facility for treatment, storage, and disposal. Selective removal of sediments already has been deemed appropriate. This technology is retained for further evaluation.

2.11.5 In-Situ Treatment

In-situ treatment includes technologies such as bioreclamation and surface bioreclamation, aeration, permeable treatment beds, chemical treatment, and soil washing/soil flushing. This technology is screened from further evaluation because:

- Depth of contamination will make implementation of these technologies difficult.
- The heterogeneity and variable depth of the fractured bedrock aquifer will make the reliability and predictability of these technologies difficult to control.
- Biodegradation is often inhibited by halogenated hydrocarbons.

2.11.6 Chemical Treatment

Chemical treatment methods include many common industrial processes such as neutralization, hydrolysis and photolysis, oxidation and reduction, ozonation, chlorination and dechlorination. These processes are generally applicable for the treatment of contaminated groundwater or liquid waste streams. However, these methods do not directly address the entire contaminant problem at the Berks Sand Pit Site and they will not be considered further.

As part of the air stripping physical treatment method, the chemical process of ion exchange will be retained for further consideration. Ion exchange can be used to lower the levels of

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calcium, manganese, and iron in the water. Hydroxides of these metals tend to precipitate and clog air strippers and adsorption media.

2.11.7 Solidification/Stabilization/Fixation Treatment

Solidification, stabilization, and fixation treatment processes are used to immobilize the contaminants in the waste. Changing the constituents into insoluble forms, binding them in an immobile, insoluble matrix, or binding them in a matrix which minimizes the material surface exposure to solvent exposure, are treatment processes that fall under this category. These processes, alone or in combination, can affect this immobilization.

Two of these processes are: 1) sorption, and 2) pozzolan-type matrices. In sorption, contaminants are bound-up in pozzolan-type matrices by physical sorption or chemisorption that yields a stabilized material which is easier to handle. Pozzolanic processes treat wastes by the addition of large amounts of siliceous materials combined with a setting agent such as lime, cement, or gypsum. Although the contaminated sediment is treatable through these two technologies, the large degree of dilution and relatively small volume of the sediment (less than 10 cubic yards) makes these technologies non-attractive. Therefore, these are eliminated from further evaluation.

Another treatment process is thermoplastic microencapsulation. This technology involves the mixing of heated, dried waste within a matrix of asphalt, bitumen, paraffin, or polyethylene, resulting in a stable solid waste mass. However, thermoplastic microencapsulation may not be particularly effective to treat waste with high-water content or containing volatile organics. This technology is eliminated from further evaluation.

2.12 Discharge/Disposal

This GRA includes either on-site or off-site discharge for the disposal of liquids. On-site disposal includes diffuse discharge of treated water (i.e., land application of treated water), discharge of treated water by injection into deep wells and discharge of treated water to a local stream(s). On-site discharge/disposal will be retained for further evaluation.

Off-site disposal includes transmitting either treated or untreated water to a local POTW. Since there are no POTWs in the vicinity of the Berks Sand Pit Site, this technology will not be considered further.

ORIGINAL (Red)

2.13 Screening Summary

A summary of the GRAs and the candidate technologies considered in the screening process, and justification for their dismissal or retention is presented in Tables 2-4, 2-5, and 2-6. Each technology was evaluated in terms of technical feasibility, as well as in terms of site-specific conditions. The result is a list of the technologies considered suitable for combination into remedial action alternatives.

AR300822

Table 2-4

SUMMARY OF SCREENING FOR GROUNDWATER

Groundwater General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve remedial action objectives.	Not acceptable to local/public government	None
Institutional Actions	Access Restrictions	Deed Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Legal requirements.	Negligible Costs.
	Alternate Water Supply	Expand Existing System	Effective in preventing use of contaminated groundwater. No contaminant reduction.	Conventional construction requires public/private agreement	High Capital Med. O&M
		New Well	Effective in preventing use of contaminated groundwater. No contaminant reduction.	Conventional construction requires local approval.	High Capital Med O&M
	Monitoring	Groundwater Monitoring	Useful for documenting conditions. Does not reduce risk by itself.	Alone, not acceptable to public/local government.	Low Capital Med O&M.
Collection	ıxtraction	Extraction	Effective for upgradient fracture flow interception.	Conventional construction readily implemented.	Med Capital High O&M
		Extraction/ Injection Wells	May not increase contaminated groundwater flow/ in the proper bedrock fracture(s).	Conventional construction readily implemented.	High Capital High O&M
Discharge	On-site Discharge	Local Stream	Effective and reliable discharge method.	Discharge permits required.	Low Capital V. Low O&M
		Injection Well	Effective and reliable dischar[illegible]hod	Conventional construction readily implemented	Med[illegible]al Med[illegible]

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Table 2-4

SUMMARY OF SCREENING FOR GROUNDWATER (continued)

Groundwater General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
Collection	Extraction	Extraction	Effective for upgradient fracture flow interception.	Conventional construction readily implemented	Med Capital High O&M
		Extraction/ Injection Wells	May not increase contaminated groundwater flow in the proper fracture(s).	Conventional construction readily implemented	High Capital High O&M
Treatment	Physical Treatment	Air Stripping	Effectively and reliably volatilizes the contaminants from the groundwater, vapor-phase gas treatment may be required.	Readily implemented.	Med. Capital Low O&M
		Carbon Adsorption	Effectively and reliably removes the contaminants from the groundwater.	Readily implemented.	Med. Capital High O&M
	Chemical Treatment	Ion Exchange/ Water Softener	Effective and reliable for the reduction of iron, manganese, and calcium in the groundwater.	Readily implemented.	Low Capital Med O&M
Discharge	On-site Discharge	Local Stream	Effective and reliable discharge method.	Readily implemented.	Low Capital V Low O&M
		Injection Well	Effective and reliable discharge method.	Readily implemented.	Med Capital Med O&M

AR300824

Table 2-5

SUMMARY OF SCREENING FOR SURFACE WATER

Surface Water General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve remedial action objectives.	Not acceptable to local/public government.	None
Institutional Actions	Access Restrictions	Deed Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Legal requirements.	Negligible
	Monitoring	Surface Water Monitoring	Useful for documenting conditions. Does not reduce risk by itself	Alone, not acceptable to public/local government.	Low Cpaital Med O&M
Collecti-	Surface Control	Collection	Effective and reliable collection method. No contaminant reduction.	Readily implemented	Low Capital Med O&M
Dischar	On site Discharge	Local Stream	Effective and reliable discharge method	Discharge permits required	Low Capital V Low O&M
		Injection Well	Effective and reliable disc[illegible] method	Conventional construction, readily implemented	[illegible]

AR300825

Table 2-5

SUMMARY OF SCREENING FOR SURFACE WATER (continued)

Surface Water General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
Collection	Surface Control	Collection	Effectively and reliably collects contaminated surface water.	Readily implemented	Low Capital Med O&M
Treatment	Physical Treatment	Stripping	Effectively and reliably volatilizes the contaminants from the groundwater vapor-phase gas treatment required	Readily implemented	Med. Capital Low O&M
		Carbon Adsorption	Effectively and reliably removes the contaminants from the groundwater.	Readily implemented	Med Capital Med O&M.
	Chemical Treatment	Ion Exchange/ Water Softener	Effective and reliable for the reduction of iron, manganese, and calcium in the groundwater.	Readily implemented	Low Capital Med O&M
Discharge	Onsite Discharge	Local Stream	Effective and reliable discharge method.	Readily implemented	Low Capital V. Low O&M
		Injection Well	Effective and reliable discharge method.	Readily implemented	Med Capital Med O&M

AR300826

ORIGINAL (Red)

Table 2-6

SUMMARY OF SCREENING FOR SEDIMENT

Sediment General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve remediation action objectives.	Not acceptable to local/public government	None
Institutional Actions	Access Restrictions	Deed Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Legal requirements.	Negligible
	Monitoring	Sediment Monitoring	Useful for documenting conditions. Does not reduce risk by itself.	Alone, not acceptable to public/local government.	Low Capital Med O&M
Removal	Excavation	Excavation	Effective and reliable conventional technology. Requires treatment/disposal of sediment.	Readily implemented	Moderate Capital
Disposal	Off-site Disposal	Off site Landfill	Effective, reliable conventional technology	Requires treatment prior to disposal.	Med Capital Negligible O&M

AR300827

Table 2-6

SUMMARY OF SCREENING FOR SEDIMENT - continued-

Sediment General Response Actions	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
Removal	Excavation	Excavation	Effective and reliable conventional technology. Requires treatment/disposal of sediment.	Readily implemented	Moderate Capital
Treatment	Thermal Treatment	Rotary Kiln	Effective and commercially available technology. Resulting ash must be landfill.	Readily implemented.	High Capital
		Fluidized Bed	Demonstration-scale units are available. Effectively incinerates wastes. Ash disposal required.	Not readily implemented	High Capital
		Pyrolysis	Effective and commercially available technology. Ash disposal required.	Readily implemented.	High Capital.
Disposal	Off-site Disposal	Off site Landfilll	Effective and reliable technology. Transportation required.	Easily implemented; treatment required prior to disposal	High Transporta tion Cost

DEVELOPMENT OF ALTERNATIVES

ORIGINAL (Red)

3.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

3.1 Purpose of the Alternatives

The goals of remedial actions at the Berks Sand Pit Site are to prevent a further increase in existing potential risks and to reduce potential future risks to human health and the environment. These goals address the risks posed by potential contamination of the following four media:

- Air
- Soil
- Groundwater
- Surface Water and Sediments

The purpose of the alternative development process is to formulate remedial action alternatives (RAAs) that address the reduction and/or the elimination of risks to human health and the environment posed by contaminants in these media.

3.2 Procedures for Alternative Development

In this section, the technologies remaining after the technology screening process in Section 2.0 are used to develop RAAs for the Berks Sand Pit Site. The RAAs developed in this manner are based on the technology, or combination of technologies that can best be expected to address the site specific situation.

Each remedial action technology was initially considered because it was judged to be applicable to the site problems. Only effective, implementable technologies were retained for further evaluation. Some of the technologies address more than one problem, whereas others may not significantly remediate any problems alone, but may be required for other technologies to be implemented effectively. Technologies subjected to the screening process, and the results of that screening were previously presented in Tables 2-4, 2-5, and 2-6.

Only the technologies that address one or more of the remediation goals and passed the screening process in Section 2.0 will be considered for inclusion into RAAs. Implementable technologies will be combined only if their combination provides remediation above and beyond that provided by an individual technology.

AR300830

3.3 Levels of Remediation to be Achieved

To evaluate the potential RAAs, the different alternatives have been categorized according to the degree of remediation they would provide. Four cleanup categories were developed to evaluate a range of RAAs. These categories are listed in ascending order of cleanup provided and meet the four cleanup goals outlined in Section 1.5. At least one RAA has been developed for each of the following categories:

I. No action

II. Alternatives that prevent a risk increase

III. Alternatives that attain applicable or relevant and appropriate requirements (ARARs) for human health

IV. Alternatives that attain ARARs for both human health and the environment

3.4 Formulation of Remedial Action Alternatives

In this section, each of the four cleanup categories are discussed with respect to the applicability of technologies that promote satisfying the goals of that category. Individual technologies that achieve the site-specific goals of each of the four categories will be identified and then combined into appropriate RAAs.

3.4.1 No Action

This cleanup category would not involve site remediation activities that reduce or prevent the migration of contaminants from the site or that reduce any resulting impacts to human health or the environment. The no action category does, however, provide for continued monitoring of existing groundwater wells and surface water sampling points. Applicable technologies that satisfy the requirements of this category include:

- Continued monitoring of surface water and groundwater
- Expanded monitoring of surface water and groundwater

Two remedial action alternatives were formulated for this category. They are 1) continued monitoring of existing groundwater wells and surface water sampling points, and 2) continued surface water and groundwater monitoring with the establishment of additional monitoring points.

AR300831

3.4.2 Alternatives that Prevent a Risk Increase to Human Health

Included in this cleanup category are alternatives based on technologies that are designed to prevent an increase in potential risks to human health. This category also may include technologies that will help prevent an increase in risk to the environment; but, this is not a requirement for this cleanup category. Applicable technologies that satisfy the requirements of this category include:

- Continued and expanded monitoring of surface water and groundwater
- Installation of an alternate water supply

One remedial action alternative was formulated to satisfy this category. This alternate includes continued surface water and groundwater monitoring with the installation of additional groundwater monitoring wells and implementation of an alternate water supply system.

3.4.3 Alternatives that Attain Applicable or Relevant and Appropriate Requirements for Human Health

This cleanup category requires alternatives that provide protection to human health. This protection is achieved by isolating or removing human exposure pathways. The contaminant-specific ARARs required to provide protection to human health are listed in Table 3-1. The alternatives in this category also may reduce risks to the environment; but, this is not a requirement for this cleanup category. The contaminant-specific ARARs for the protection of the environment based on water quality criteria are also listed in Table 3-1. Technologies that could be combined to form alternatives capable of achieving these requirements for the protection of human health include:

- Continued and expanded surface water and groundwater monitoring
- Installati of an alternate water supply
- Extraction of contaminated groundwater
- Treatment of contaminated groundwater by air stripping
- Treatment of contaminated groundwater by carbon adsorption
- Treated water discharge to the watershed
- Excavation and disposal of contaminated sediments

AR300832

Table 3-1

BERKS SAND PIT SITE
SUMMARY OF PUBLIC HEALTH AND ENVIRONMENTAL CRITERIA
CONTAMINANT-SPECIFIC ARARs

	1,1-Dichloroethene	1,1-Dichloroethane	1,1,1-Trichloroethane	Tetrachloroethene
AIC - µg/kg/day				
Oral	10	120	90	10
Reference	IRIS	HEA	IRIS	HEA
Inhalation	-	138	6,000	-
Reference	-	HEA	HEA	-
PF - $(\mu g/kg/day)^{-1}$				
Oral	600	-	-	51
Reference	IRIS	-	-	HEA
Weight of Evidence	C	-	-	B2
Inhalation	1,200	-	-	1.7
Reference	IRIS	-	-	HEA
Weight of Evidence	C	-	6,000	B2
MCL - µg/l	7	-	200	-
EPA - WQC - µg/l				
Human Health				
Water and Fish	3.3×10^{-2}	9.4×10^{-1}	1.8×10^{4}	8.0×10^{-1}
Fish Only	1.85	2.43×10^{2}	1.03×10^{6}	8.85
Aquatic Organisms				
Acute	1.16×10^{4}	1.8×10^{5}	5.28×10^{4}	5.8×10^{3}
Chronic	-	2.0×10^{4}	-	8.4×10^{2}

AIC = Acceptable intake for chronic exposure
MCL = Maximum Contaminant Level
IRIS = Integrated Risk Information System
HEA = Health Effects Assessment
PF = Potency Factor
WQC = Water Quality Criteria
C, B2 = Refer to Remedial Investigation, Table 6-2: Categories for Potential Carcinogens

AR300833

Two remedial action alternatives were developed to meet the requirements of this category: (1) continued and expanded surface water and groundwater monitoring with the installation of additional monitoring wells, installation of an alternate water supply system, extraction of contaminated groundwater with treatment by air stripping, discharge of treated water to the watershed, and excavation of contaminated sediments; and (2) continued and expanded surface water and groundwater monitoring with the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction with treatment by carbon adsorption, discharge of treated water to the watershed, and excavation of contaminated sediments. These two alternatives likely will attain the ARARs for the environment as well as for human health. However, the discharge of a large volume of treated water to the watershed may have an adverse impact on local streams.

3.4.4 Alternatives that Meet or Exceed Applicable or Relevant and Appropriate Requirements for both Human Health and the Environment

This cleanup category requires alternatives that provide protection to both human health and the environment. RAAs in this category have been developed to provide control of both human and environmental exposure pathways. Applicable technologies that could be combined to achieve the requirements of this category include:

- Continued and expanded surface water and groundwater monitoring
- Installation of an alternate water supply
- Extraction of contaminated groundwater
- Treatment of contaminated groundwater by air stripping
- Treatment of contaminated groundwater by carbon adsorption
- Treated water discharge by injection into the aquifer
- Excavation and disposal of contaminated soils

Two remedial action alternatives were developed to meet the requirements of this category: (1) continued and expanded surface water and groundwater monitoring with the installation of additional monitoring wells, installation of an alternate water supply, extraction of contaminated groundwater with treatment by air stripping and discharge of treated water by injection, and excavation of contaminated sediments; and (2) continued and expanded surface water and groundwater monitoring with the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction with treatment by

AR300834

ORIGINAL

carbon adsorption and discharge of treated water by injection, and excavation of contaminated sediments.

3.5 Summary of Remedial Action Alternative Development and Levels of Remediation

During the alternative development, several applicable remedial technologies were identified for each of the four required cleanup categories. The technologies presented for each category were combined into RAAs to meet the specified levels of remediation. A total of seven RAAs were developed for the Berks Sand Pit Site. The RAAs generated for each category are summarized below:

I. No Action

RAA No. 1. Continued monitoring of existing wells (groundwater) and surface water

RAA No. 2. Surface water and groundwater monitoring, including the installation of additional monitoring wells

II. Alternatives that Prevent an Increase in Risk to Human Health and the Environment

RAA No. 3 Surface water and groundwater monitoring, including the installation of additional monitoring wells and installation of an alternate water supply system

III. Alternatives that Meet or Exceed ARARs for Human Health

RAA No. 4. Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by air stripping with vapor phase carbon adsorption, discharge of treated water to the watershed (stream), and the excavation, off-site treatment by incineration and disposal of the contaminated sediments.

RAA No. 5. Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by carbon

AR300835

adsorption, discharge of treated water to the watershed (stream), and the excavation, off-site treatment by incineration and disposal of the contaminated sediments.

IV. Alternatives that Meet or Exceed ARARs for Human Health and the Environment

RAA No. 6 Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by air stripping with vapor phase carbon adsorption, discharge of treated water by reinjection into the aquifer, and the excavation, off-site treatment by incineration and disposal of contaminated sediments.

RAA No. 7 Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by carbon adsorption, discharge of treated water by reinjection, and the excavation, off-site treatment by incineration and disposal of contaminated sediments.

AR300836

IDENTIFICATION ALTERNATIVES

4.0 IDENTIFICATION OF REMEDIAL ACTION ALTERNATIVES

Seven remedial action alternatives (RAAs) have been developed in Section 3.0 based on technologies or combinations of technologies that are applicable to the conditions at the Berks Sand Pit Site. Each of these RAAs will be described in detail in the following sections.

4.1 Remedial Action Alternative No. 1 - No Action

The no action alternative is included to provide a baseline to compare the relative effectiveness of the other RAAs. Under this alternative, no remedial measures are proposed for implementation at the Berks Sand Pit Site. The no action alternative does include provisions for monitoring both surface water and groundwater on a regular basis. Although no additional monitoring points will be installed, the existing residential and monitoring wells and surface water sampling points will be monitored. Specifically, 18 residential wells, 9 deep monitoring wells, 10 shallow monitoring wells, and 13 surface water seeps will be sampled. The purpose of continued monitoring is to track the migration of the plume and to further define the extent, migration, and fate of contaminants. Samples will be collected annually as described in Section 4.2. Design details and costs for the no action alternative are given in Appendix A.

An environmental review of the site will be conducted every five years as required under Section 121(c) of SARA as long as hazardous substances, pollutants, or other contaminants that may pose a threat to human health or the environment remain at the site.

4.2 Remedial Action Alternative No. 2 - No Action with Expanded Monitoring

Implementation of this RAA includes continued sampling of existing monitoring and residential wells, and surface water sources as well as the installation and sampling of at least seven monitoring well clusters with three wells per cluster. Samples will be collected annually. Figure 4-1 shows a generalized implementation procedure for the monitoring system and design details and costs are given in Appendix A.

Numerous activities will be performed prior to and during the installation of the monitoring system. The primary purpose of the activities listed here, and for the other alternatives presented in the later sections, is to complete existing data gaps in order to better define the complex geologic and hydrogeologic systems at the Berks Sand Pit Site. The results of these

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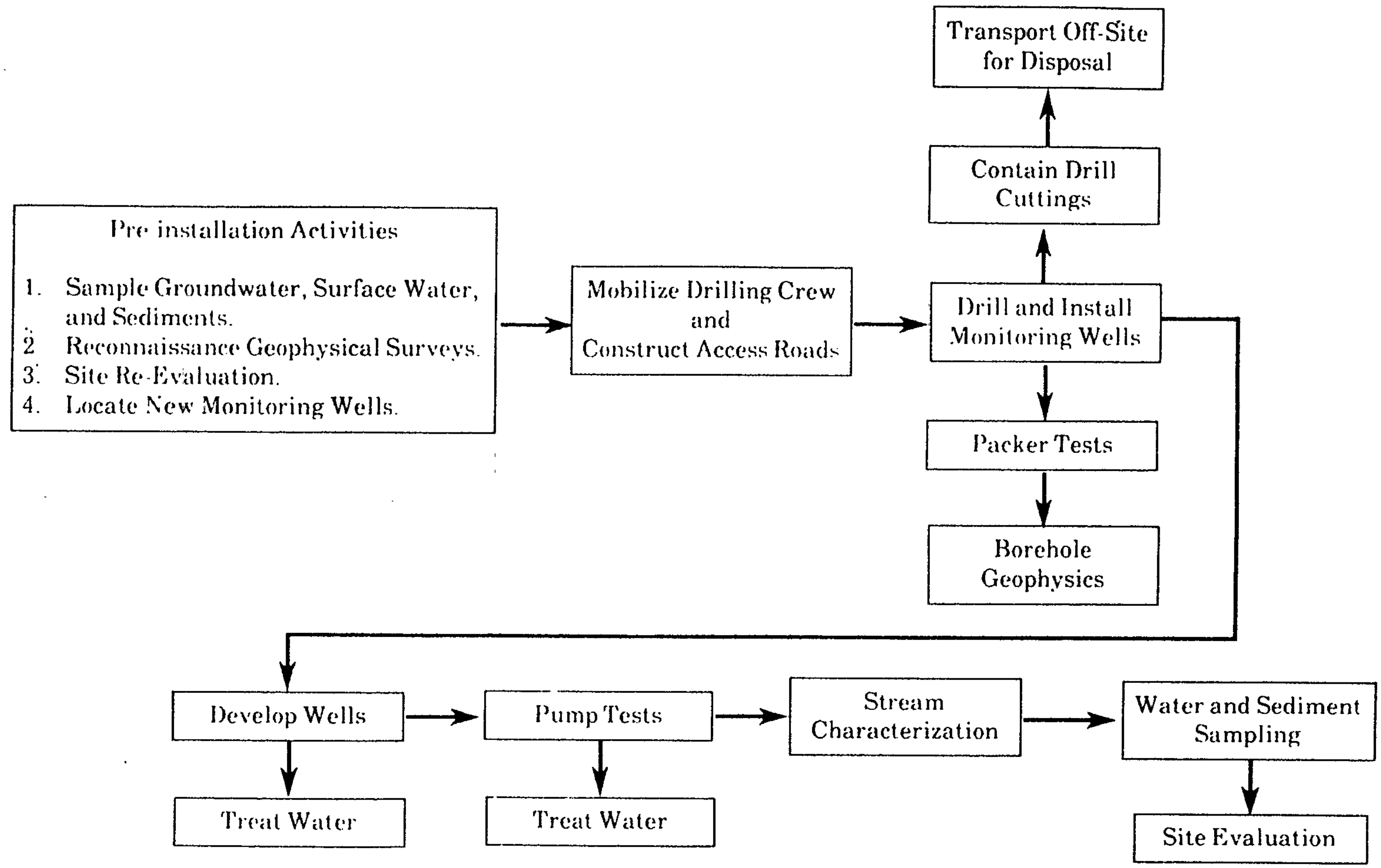

Figure 4-1

GENERALIZED IMPLEMENTATION PROCEDURE FOR MONITORING SYSTEM

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activities will provide additional information about the geology and hydrology of the site, and will better define the extent, migration, and fate of contaminants in the vicinity of the site. This information also may be necessary for the development of a final design for the preferred alternative.

Although specific additional information will be necessary for the successful and efficient application of most technologies, these ancillary activities will only be described in the most general terms. The activities applicable to the monitoring system include:

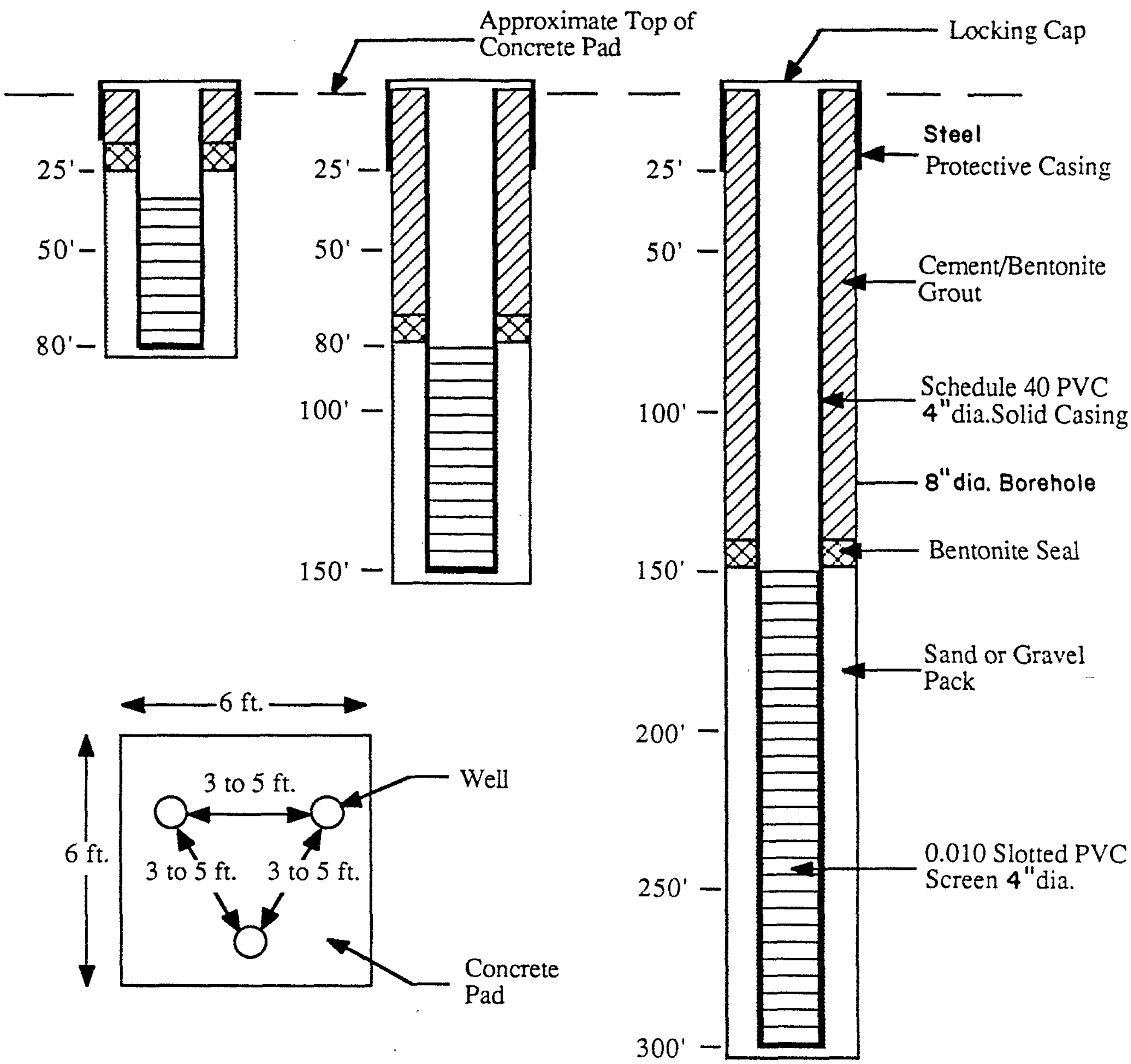
- Pre-implementation sampling and site re-evaluation
- Reconnaissance geophysical surveys
- Borehole geophysics
- Packer tests
- Pump tests
- Stream characterization (flow rates, chemistry, biota, etc.)

The monitoring well system was designed to supplement the existing monitoring wells in monitoring both the upgradient and downgradient water quality over a large range of depth in the fractured bedrock aquifer. The monitoring well system will utilize a minimum of seven, three-well clusters. Each well will be at least 4 inches in diameter to facilitate purging and sampling. Typical construction details for the monitoring wells are given in Figure 4-2. The monitoring system also was designed to supplement the evaluation of surface waters and to estimate the downstream extent of contamination.

Some possible locations for the additional monitoring wells are given in Drawing 4. At least three well clusters should be placed at downgradient locations since the Remedial Investigation (RI) did not delineate the full downgradient extent of contamination. At least three well clusters should also be placed cross-gradient or to the sides of the suspected area of contamination. These well clusters will better define the north-south extent of contamination and secondary flow paths. At least one well cluster should be placed upgradient of the contaminant plume to monitor the background groundwater conditions. The actual number, location, and depths of the monitoring wells should be based on further field observations such as geophysical surveys, borehole logging, packer tests, and analytical results.

Annual samples will be collected from at least 18 residential wells, 40 monitoring wells (including the seven newly installed well clusters), and 18 surface water and sediment

AR300840



Notes:

1.) Wells are cased or screened for the entire depth of the borehole to prevent caving of the hole.

2.) Large screen lengths are used because of the heterogeneous nature of the aquifer (ie.,Fractures).

FIGURE 4-2

BERKS SAND PIT

CONSTRUCTION DETAILS FOR A TYPICAL MONITORING WELL CLUSTER sampling points. The actual number of samples will depend on the additional sampling points included in the monitoring system, the areal distribution of the contaminants, and the perceived threat to human health and the environment. Annual samples will be collected and analyzed for eight Pennsylvania-regulated volatile organic compounds (see Table 4-1 and Appendix A).

All wells will be purged a minimum of three to five well volumes of water prior to sampling. The water level in each well will be measured before purging. The purging technique will depend on the well being sampled; residential wells will be purged by pumping the domestic pumps set in the wells; and monitoring wells will be purged either with a stainless steel electric submersible pump or with a dedicated PVC bailer, depending on the diameter of the well. Sampling will be performed on the same day that the well is purged.

To avoid cross-contamination of samples, downstream points will be sampled prior to upstream points for surface water and sediment samples. Samples will be collected with a nalgene or glass beaker and immediately transferred to the appropriate sample containers. Surface waters will be collected prior to sediment samples.

Prior to sampling, and between each sampling point, the equipment will be thoroughly decontaminated. The decontamination procedure includes washing all equipment prior to and between sampling with an Alconox and water solution. The equipment then will be rinsed with potable water, nitric acid, and acetone or methanol. The final rinse will consist of deionized/distilled water.

Samples will be filtered and preserved, as appropriate, in the field and immediately placed on ice. Measurement of temperature, pH, and specific conductance will be taken in the field. Chain-of-custody forms also will be completed and checked in the field.

As per the no action alternative, a review of the site conditions will be performed every five years.

4.3 Remedial Action Alternative No. 3 - Alternate Water Supply and Monitoring

Implementation of this RAA includes continued monitoring of the groundwater and surface water at the site plus the construction of an alternate water supply system to replace the resident's domestic wells. The monitoring portion of this alternative is described in

AR300842

Table 4-1

ANNUAL ANALYSIS OF SAMPLES

<u>Pennsylvania Regulated Volatile Organic Compounds</u>

Trichloroethene	1,2-Dichloroethane
Carbon Tetrachloride	Vinyl Chloride
1,1,1-Trichloroethane	p-Dichlorobenzene
Benzene	1,1-Dichloroethene

AR300843

Section 4.2. The alternate water supply system is described in the following paragraphs and design details are given in Appendix A. A generalized diagram showing the implementation of the alternate water supply is given in Figure 4-3. The components of the water supply system are shown in Drawing 2 and optional systems are shown in Drawing 3.

As with the monitoring system, numerous activities should be performed prior to and during implementation of this RAA. These include:

- Reconnaissance geophysical surveys
- Borehole geophysics
- Geotechnical field and laboratory tests
- Short-term pump tests
- Long-term pump tests
- Laboratory tests to determine water treatment requirements

An alternate water supply (AWS) system was designed to replace the individual potable water supply wells in the vicinity of the Berks Sand Pit Site. The system design was based on 27 dwellings identified as being at risk from the use of contaminated groundwater as a potable water source. For this design, it was assumed that four people occupy each of the dwellings and use water at an average rate of 181 gpd for Pennsylvania. In addition, it was assumed that the population to be serviced will increase by 25 percent during the design lifetime of the system. Preliminary design calculations were verified with the Kentucky Pipes computer program. System pressures were evaluated during worst case demand scenarios for cast iron and polyethylene plastic main lines. A minimum pressure of 20 psig at all points in the system was used to evaluate the worst case operating scenarios. Water distribution pipes were sized to convey the peak hourly potable demand. The preliminary design was based on 8-inch diameter water distribution mains. Later revisions to the AWS modified the flow rate; however, the pipe size for the main lines was not re-designed. The final design should consider smaller pipe sizes.

Two water supply pumping wells were required based on typical well yields documented for the granitic gneiss formations of the region based on PADER Water Resources Report No. 44 and data obtained during the RI. These two pumping wells were assumed to yield 35 gpm each with a 200-foot depth. The water supply wells were located in the valley near the intersection of Benfield Road and the highway between Huff's Church and Henningsville. This location was selected for the following reasons:

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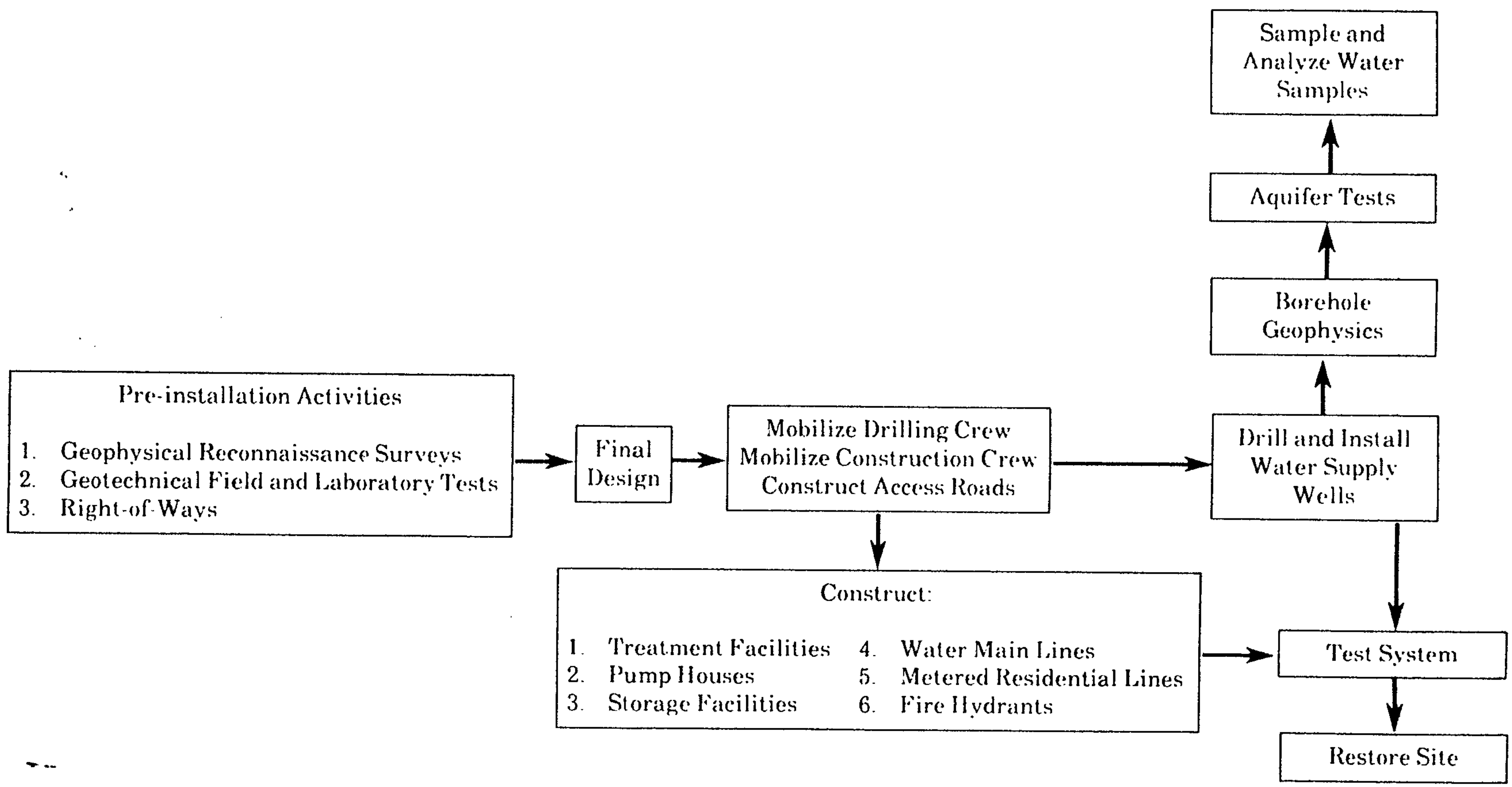

Figure 4-3

GENERALIZED IMPLEMENTATION PROCEDURE FOR THE PUBLIC WATER SUPPLY SYSTEM

- This location is relatively distant from the zone of contaminated groundwater and pumping at this location is not likely to induce contaminant migration from the Berks Sand Pit Site towards the water supply wells.

- Obtaining adequate yields from the granitic gneiss formation required the wells to intercept fractured zones in the bedrock aquifer (in general, fractures are more likely to be found in valleys rather than at higher elevations).

- Groundwater recharge in the valley area is expected to be greater than at higher elevations, thereby reducing the potential for the wells to be pumped dry during the design life of the system.

The major components of the water supply system include: two pumping wells, a booster pump/treatment building with amenities, a 50,000-gallon steel storage tank, various piping including an 8-inch diameter polyethylene main distribution line, metered residential service connections, and ancillary equipment. The booster pump was sized to deliver flow from the pump/treatment building, located near the pumping wells, to the steel storage tank located at an approximate elevation of 1,070 feet above MSL. The steel storage tank was sized to contain two days of storage at maximum daily flow demand as recommended in Part II of the Pennsylvania Department of Environmental Resources Public Water Supply Manual. Full flow gravity main lines were designed to distribute potable water through the system to the serviced dwellings during worst case flow demand conditions. The construction of this system should proceed according to normally accepted standards as described by the American Water Works Association.

In addition to the previously discussed AWS, two optional water supply systems were evaluated, as shown on Drawing 3, and include: 1) extending the water supply system from the Town of Topton, and 2) extending the water supply system from the Mt. Village Trailer Park. Preliminary designs and costs for these optional water supply systems are given in Appendix A. The distribution system for these two options is the same as previously described.

As under the no action alternative, an environmental review of the site will be performed every five years.

4.4 Remedial Action Alternative No. 4 - Monitoring, Alternate Water Supply, Groundwater Extraction, Air Stripping with Vapor Phase Carbon Adsorption, Discharge of Treated Water to the Watershed, and Excavation, Treatment and Disposal of Contaminated Sediments

Implementation of this RAA includes monitoring of the surface and groundwater quality, construction of an alternate water supply system, installation and operation of a groundwater extraction system to remove contaminated water from the aquifer, and the construction of an air stripping treatment system with vapor phase carbon adsorption. The treated groundwater will be discharged to the watershed. Contaminated sediments will be excavated and transported off-site for treatment by incineration and disposal. Figure 4-4 is a generalized process diagram showing the major components of this RAA. The primary purpose of this RAA is to reduce the risk to human health (water supply and excavation) and the environment (extraction) by effecting a cleanup (extraction and treatment) of the contaminated groundwater. The monitoring portion of this alternative is discussed in Section 4.2; the alternate water supply system is discussed in Section 4.3; and the following paragraphs will cover the other aspects of this alternative.

The groundwater extraction system was designed to create a hydraulic barrier to retard contaminant movement and to extract contaminated groundwater from the fractured bedrock aquifer upgradient of the extraction wells. The groundwater extraction system also is likely to dewater the springs and seeps in the vicinity of the pumping wells. Figure 4-5 is a generalized implementation procedure for the extraction system. The extraction system will consist of a line of five well clusters spaced approximately 206 feet apart. Each cluster will consist of three, 6-inch diameter wells of 80-foot, 150-foot, and 300-foot depths. The pumping rate for these wells is estimated to be 5, 20, and 10 gpm, respectively, with a total extraction rate of 35 gpm per well cluster (175 gpm total for all five well clusters). The screened intervals were designed so that the entire depth of the potentially contaminated zone, from 30 feet to 300 feet, can be pumped. Figure 4-6 illustrates the typical extraction well construction and Drawing 4 shows some possible well cluster locations. Design details are given in Appendix A.

The groundwater extraction system specifies five, three-well clusters spaced approximately 206 feet apart over 1,030 feet, the estimated width of the plume. This configuration gives an elongated zone of drawdown perpendicular to the hydraulic gradient with overlapping capture zones influencing a 1,236-foot line across the plume. The five well clusters were distributed across the gradient to create a large zone of horizontal control, and to increase the

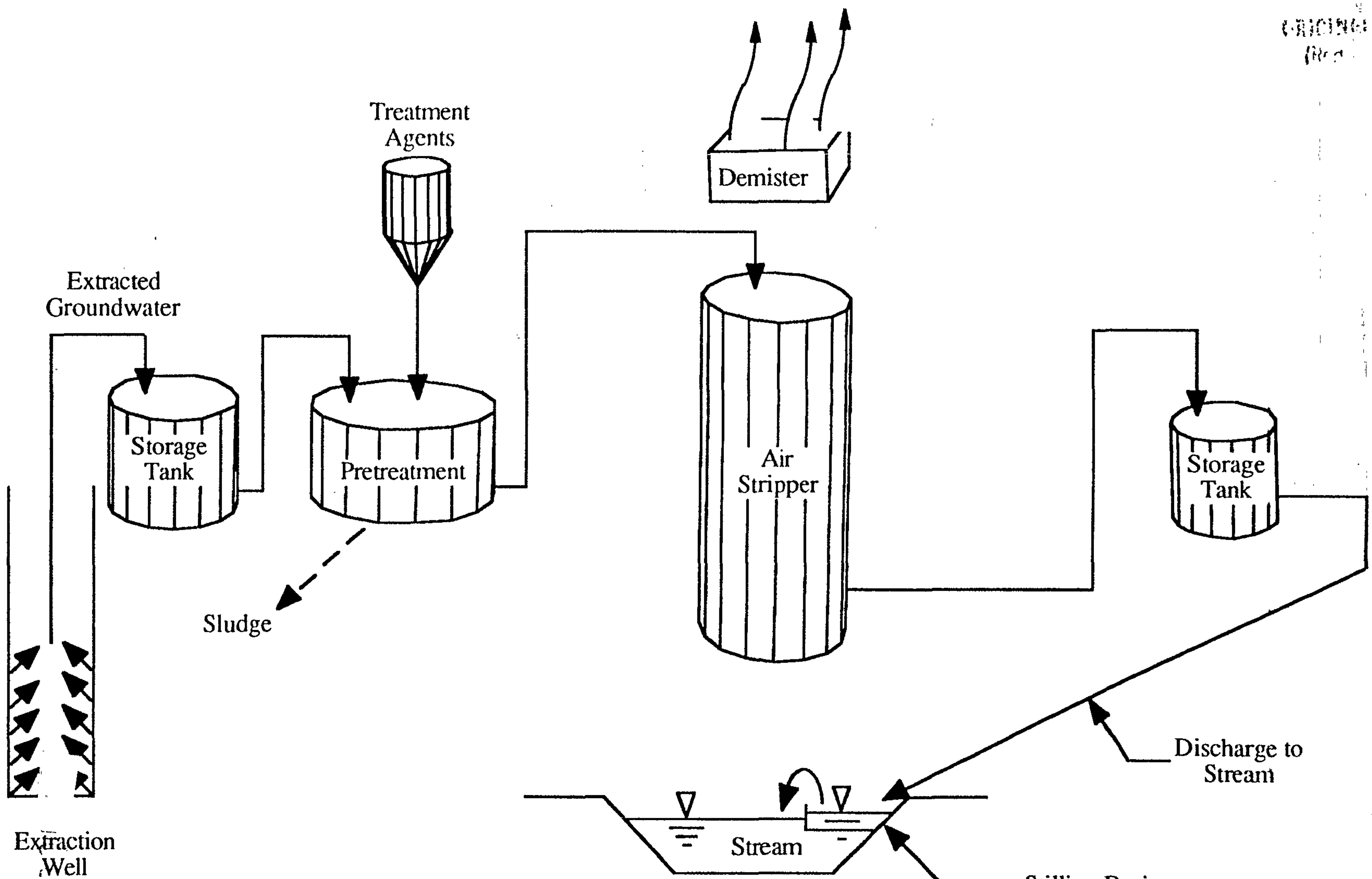

FIGURE 4-4

BERKS SAND PIT

GENERALIZED PROCESS DIAGRAM FOR RAA NO. 4

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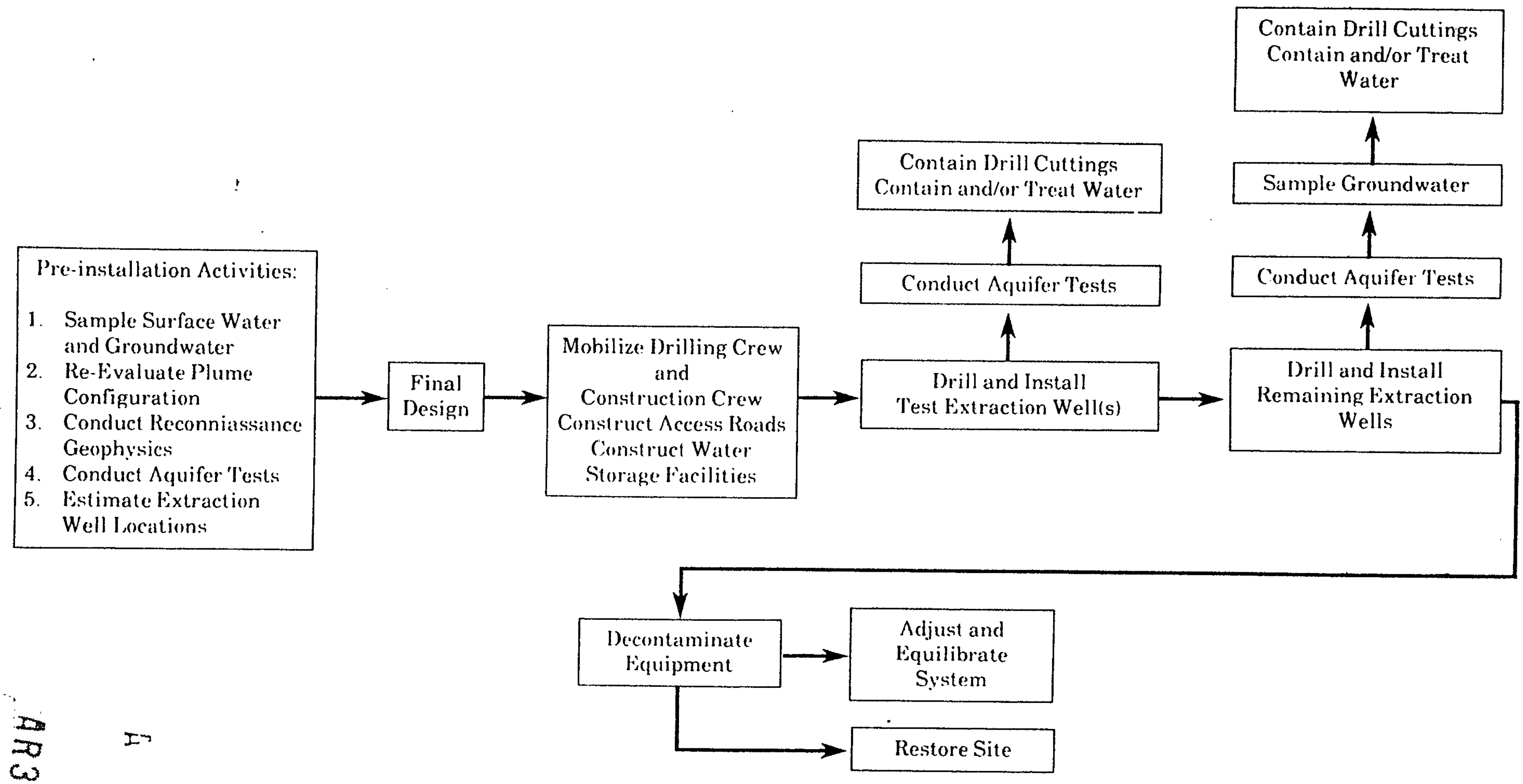

Figure 4-5

GENERALIZED IMPLEMENTATION PROCEDURE FOR EXTRACTION WELL SYSTEM
(RAA NO. 4 - RAA NO. 7)

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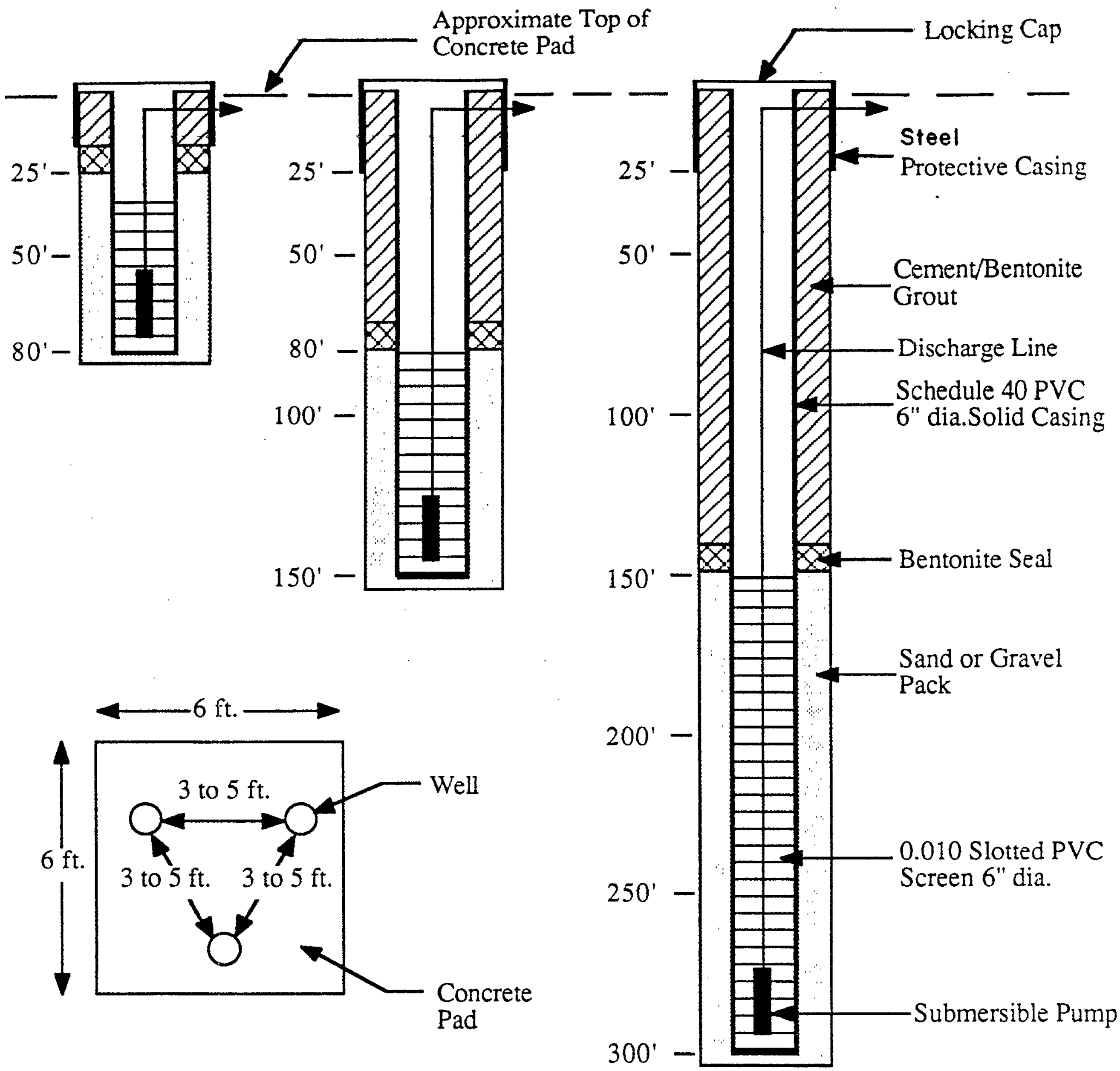

Notes:

1.) Wells are cased or screened for the entire depth of the borehole to protect the pumps and to prevent caving of the hole.

2.) Large screen lengths are used because of the heterogeneous nature of the aquifer (ie., Fractures).

FIGURE 4-6

BERKS SAND PIT

CONSTRUCTION DETAILS FOR A TYPICAL EXTRACTION WELL CLUSTER

AR300850

potential influence over individual and/or isolated fractures. Well clusters also were used to create a large degree of vertical control and flexibility. The system was designed to capture a significant portion of the contamination upgradient from the extraction wells. Initially the capture zones will extend approximately 30 feet to 35 feet downgradient from the extraction wells. For this reason, the extraction system should be placed near the leading edge of contamination (i.e., near the leading edge of the 200 µg/l concentration contour for TCA).

The design pumping rates for the wells are based on the results of pump tests conducted during the RI. A total pumping rate of 35 gpm per well cluster was used. This rate was divided unequally among the three wells in each cluster. The two deeper wells (150 feet and 300 feet) were assigned pumping rates of 20 gpm and 10 gpm, respectively; the shallow wells (80 feet) were assigned pumping rates of 5 gpm each. The actual pumping rate for each well should be based on further field studies such as pump tests and should be optimized in the field.

It is estimated that this extraction system should be operated for approximately 10 (three pore volumes) to 34 (10 pore volumes) years. This is based on the estimated amount and relative mobility of contaminants in the system. It was assumed that the organic contaminants at the site, TCA and DCE, display a relatively high mobility index (MI) or a retardation factor close to one. This indicates that the contaminant velocity is likely to be close to the velocity of the water. In general, DCE is slightly more mobile in soil (MI = 4.9) than TCA (MI = 4.0) (1). The high mobility of these contaminants indicates that at least approximately three pore volumes of liquid (10 years) may be sufficient to remove these constituents from the system. The duration of pumping also will depend on soil conditions, geologic conditions, and the mobility of the contaminants. The pumping system should be closely monitored to obtain the actual extraction rates and contaminant concentrations.

The drawdowns in the pumping wells were estimated by the Cooper-Jacob Method and by Theis's Method (see Appendix A). The maximum drawdowns were estimated to be 37.9 feet below static water level (SWL) after one day of pumping to 43.4 feet below SWL after 1,000 days (2.7 years) of pumping. These drawdown values are only estimates, which may vary significantly because of the heterogeneity and anisotropy of the fractured bedrock aquifer, and because actual pumping rates may be different from the estimated rates. It is likely, however, that the drawdowns will increase over time, as indicated by the calculations, and slowly dewater the aquifer to a progressively larger extent. It is possible that portions of the shallow aquifer will be dewatered. This will tend to control contaminant discharges from

AR300851

the groundwater to the surface water. Diversion of treated water to the springs can be used to maintain the surface water flow rates.

The design of this extraction system necessitated making numerous assumptions about the hydrologic system. Following is a discussion of some of the assumptions used for this design.

- The aquifer at the Berks Sand Pit Site was assumed to be homogeneous and isotropic. The fractured bedrock is actually heterogeneous and anisotropic. The purpose of this assumption was to allow the estimation of hydrologic parameters and to allow for the application of classical flow equations such as the Theis equation to the design of an extraction system. Modifications to the system design may be necessary after further field studies and during construction to create a more efficient and effective extraction system.

- The assumptions made to estimate the requisite hydrologic parameters for the extraction system design include:

  - The transmissivity and pumping rate estimates were based on the assumption that MW-1 exhibits behavior representative of a well in a fractured zone. This assumption should be confirmed during further field investigations.

  - The hydraulic gradient was assumed to be constant across the site. The gradient may actually vary significantly across the site because of the fractured nature of aquifer and other heterogeneities. However, based on the available information, this appears to be a reasonable assumption for a preliminary design.

- The extraction well spacing was based on the assumptions that all extraction wells will be placed on fractured zones and that the aquifer thickness equals the effective saturated thickness that is yielding water to the pumping well. Based on the available information, these assumptions were necessary for the design of an extraction system. Significant variation, however, between actual system performance and ideal system performance should be expected. The actual performance of the extraction system should be closely monitored. The extraction well spacing also was based on an assumed width of the contaminant plume.

AR300852

- The pumping duration is based primarily on the assumption that TCA and DCE are conservative and mobile constituents. This assumption should be verified by water quality monitoring during operation of the extraction system.

The validity of these assumptions in designing an effective and efficient extraction system should be evaluated based on the results of further field studies and real time extraction system performance. Some laboratory, site preparation, and ancillary activities affecting the design and performance of the extraction system will be discussed later in this section.

This RAA also includes an air stripping treatment system preceded by a process to remove the metals. The treatment system was designed to remove volatile organic compounds, and certain metals from the groundwater. The treatment system consists of four primary components: (1) an influent storage tank; (2) a pretreatment system; (3) an air stripping system with vapor phase carbon adsorption, and (4) a treated water (effluent) storage tank. The system was designed to treat a maximum of 300 gpm of water with a TCA concentration of 13,000 µg/l and a DCE concentration of 7,300 µg/l. Implementation of this treatment system is illustrated in Figure 4-7, and design details are given in Appendix A.

Since it is expected that the flow rates and contaminant concentrations coming from each well cluster will be different, the water from the extraction system will be pumped into a closed, pretreatment storage tank. This will tend to smooth perturbations in the flow rate and contaminant concentrations and allow the treatment system to operate more efficiently. The contaminated influent will be pumped from the storage tank through the pretreatment system. Pretreatment is necessary so that suspended solids and precipitation of metals do not foul the packing material in the air stripper. The pretreatment system includes a filter and two ion exchange units. The filter is included to remove suspended solids from the water. The first ion exchange unit is designed to remove hardness (calcium and magnesium). The second unit is designed to remove iron from the water.

The next, and primary component of the treatment system, is an air stripping tower. A countercurrent air stripping tower was designed to remove greater than 99 percent of the TCA and DCE from the groundwater. The air stripper was designed on the basis of a 300 gpm flow rate with a mass loading of 75 pounds per day of contaminants. The tower will be 4 feet in diameter and 30 feet in height with an air to water ratio of 50:1 with this mass loading. The concentration of volatile organics in the air emissions would be about 90 mg/kg

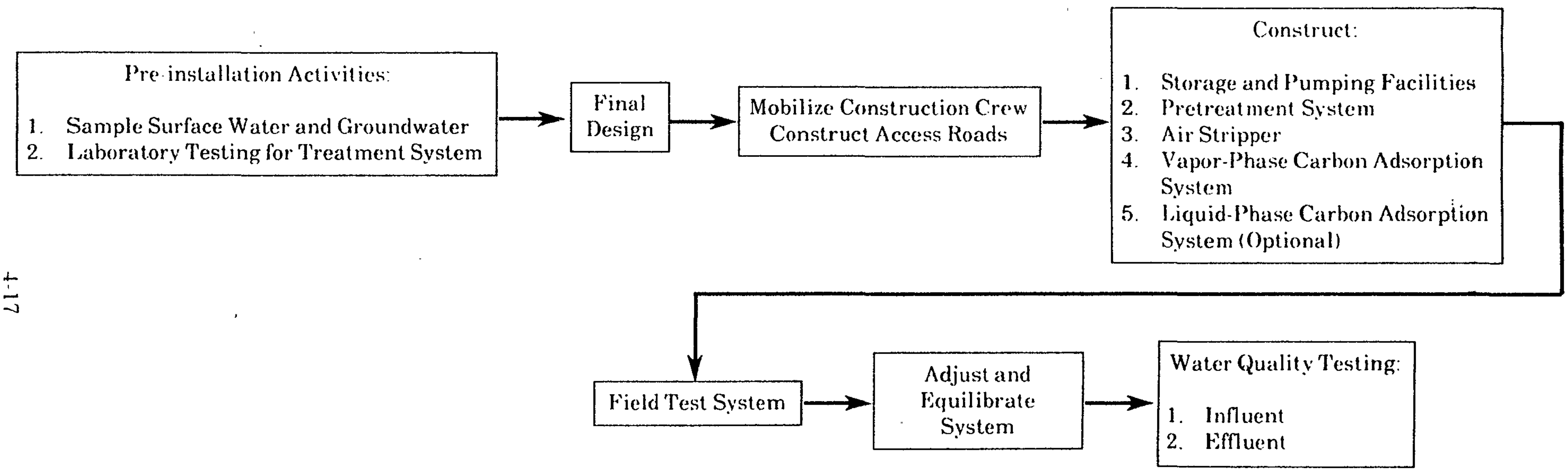

Figure 4-7

GENERALIZED IMPLEMENTATION PROCEDURE FOR AIR STRIPPING TREATMENT SYSTEM

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The air stripper was designed with a vapor phase carbon adsorption system to reduce the concentration of the volatile organics in the stripper off-gas. The system consists of an air heater and vapor phase carbon adsorption bed. The carbon adsorption bed is 10 feet in diameter and contains 314 cubic feet of activated carbon. The expected removal efficiency of the unit is 90 percent. Preliminary designs and costs for the vapor phase carbon adsorption system are given in Appendix A.

An optional liquid phase carbon adsorption system also is shown on Figure 4-7. This would be employed if the air stripper system was not adequately removing the contaminants from the groundwater, or if the groundwater was to be used as an alternate water source. This liquid phase system would consist of two 10-foot diameter vessels, each containing 10,000 pounds of carbon. Remedial Action Alternative No. 5 uses liquid phase granulated activated carbon as the primary treatment technology. Preliminary design and costs for the liquid phase carbon adsorption treatment system option are given in Appendix A.

The final component of the treatment system is a treated water (effluent) storage tank. The storage tank will serve as a reservoir from which the treated water may be monitored and discharged. The tank was designed with a maximum of 12 hours holding time to protect the environment in case of a system failure. Flow will be constant in order to minimize the possibility of freezing in the stilling basin. The tank also may be used as a pumping station to distribute water to the discharge system.

For this RAA, the treated water will be discharged to the West Branch of Perkiomen Creek approximately one mile east of the village of Huffs Church. The discharge water will be pumped via an underground pipeline into a stilling basin before being discharged to the creek. The quality and quantity of the effluent will be closely monitored and adjusted so as to minimize adverse impacts on Perkiomen Creek and comply with NPDES requirements. The implementation of this technology is illustrated in Figure 4-8.

Finally, this RAA includes provisions for the removal and off-site treatment and disposal of contaminated sediments. The extraction system is designed to lower the groundwater surface to below the topographic (ground) surface. This will cause the springs and seeps, and hence the sediments, to dry-up in the vicinity of the extraction wells. The contaminated sediments will then be excavated, containerized, and transported to an off-site RCRA-approved facility for treatment by incineration and subsequent disposal. The purpose for removing these sediments from the site is to reduce the risk of dermal contact or ingestion of the sediments.

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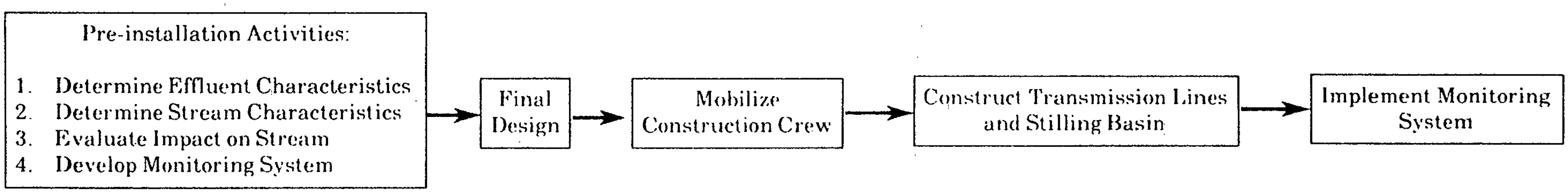

Figure 4-8

GENERALIZED IMPLEMENTATION PROCEDURE FOR DISCHARGE TO STREAM
(RAA NO. 4 - RAA NO. 5)

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An automatic monitoring system will be installed in order to observe the operations of the equipment and notify appropriate personnel of a system malfunction. The implementation of this technology is shown in general terms in Figure 4-9 and design details are given in Appendix A.

Site preparation and ancillary activities should be conducted prior to and during the implementation of this RAA in addition to activities described in previous sections to better define the complex geologic and hydrogeologic system and to provide the requisite information for final design. A brief description of some of these activities follows:

- Extraction system
  - Reconnaissance geophysical surveys
  - Borehole geophysics
  - Packer tests
  - Pump tests (long and short-term)
  - Water quality analyses (i.e., concentration versus time of pumping)

- Treatment system
  - Pretreatment laboratory tests
  - Laboratory column testing
  - Other bench scale tests

- Discharge system
  - Surface water quality analysis
  - Stream characterization (flow rates, biota, cross sections)

- Excavation and disposal/treatment of sediments
  - Surface water and sediment sampling
  - Delineation of volumes to be excavated

As with the no action alternative, an environmental review of the site remediation will be performed every five years as long as hazardous substances or other contaminants that may pose a threat to human health or the environment remain at the site.

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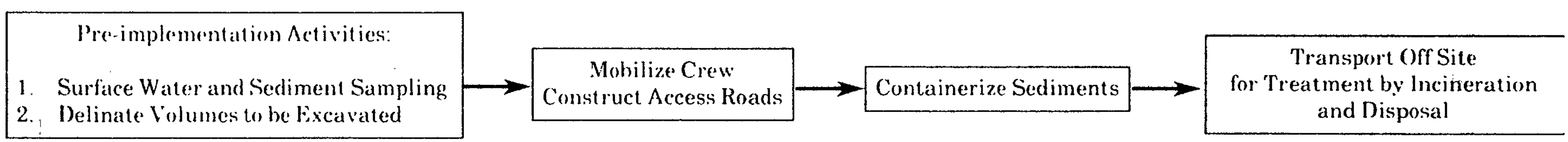

Figure 4-9

GENERALIZED IMPLEMENTATION PROCEDURE FOR SEDIMENT EXCAVATION, OFF-SITE TREATMENT BY INCINERATION AND DISPOSAL

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4.5 Remedial Action Alternative No. 5 - Monitoring, Alternate Water Supply, Groundwater Extraction, Liquid-Phase Carbon Adsorption Discharge to the Watershed, and Excavation, Treatment, and Disposal of Contaminated Sediments

Implementation of this RAA includes monitoring of the surface water and groundwater quality, construction of an alternate water supply system, installation and operation of a groundwater extraction system to remove contaminants from the aquifer, and the construction and operation of a liquid-phase carbon adsorption treatment system to treat the groundwater. The treated groundwater will be discharged to the watershed and the contaminated sediments will be transported off site for treatment by incineration and disposal. This RAA is designed to reduce risks to both human health and the environment and to cleanup the contaminated groundwater at the site. The monitoring portion of this alternative is described in Section 4.2; the alternate water supply is described in Section 4.3; and the groundwater extraction, discharge to the watershed, and treatment and disposal of sediments are described in Section 4.4. The only difference between this alternative and the one presented in Section 4.4 (RAA No. 4) is the use of a liquid-phase carbon adsorption treatment system instead of an air stripping treatment system. Additional activities such as those described in Section 4.4 also should be conducted for this alternative. A generalized process diagram illustrating the primary components of this system is given in Figure 4-10 and design details for the liquid phase carbon adsorption treatment system are given in Appendix A.

The liquid-phase carbon adsorption treatment system was designed to remove volatile organic compounds from the groundwater. This treatment system consists of four primary components. (1) an influent storage tank; (2) a pretreatment system; (3) a liquid phase carbon adsorption unit; and (4) a treated water (effluent) storage tank. This system was designed to treat approximately 175 gpm of water with a TCA concentration of 13,000 µg/l and a DCE concentration of 7,300 µg/l. This is a worst case design; the final design should be based on further field studies and laboratory bench-scale tests. A generalized implementation procedure for this system is given in Figure 4-11.

Since it is expected that the flow rates and contaminant concentrations coming from each well will be different, the water from the extraction system will be pumped into a closed, pretreatment storage tank. This will tend to smooth perturbations in the flow rate and contaminant concentrations, and allow the treatment system to operate more efficiently. The contaminated influent will be pumped from the storage tank through the pretreatment

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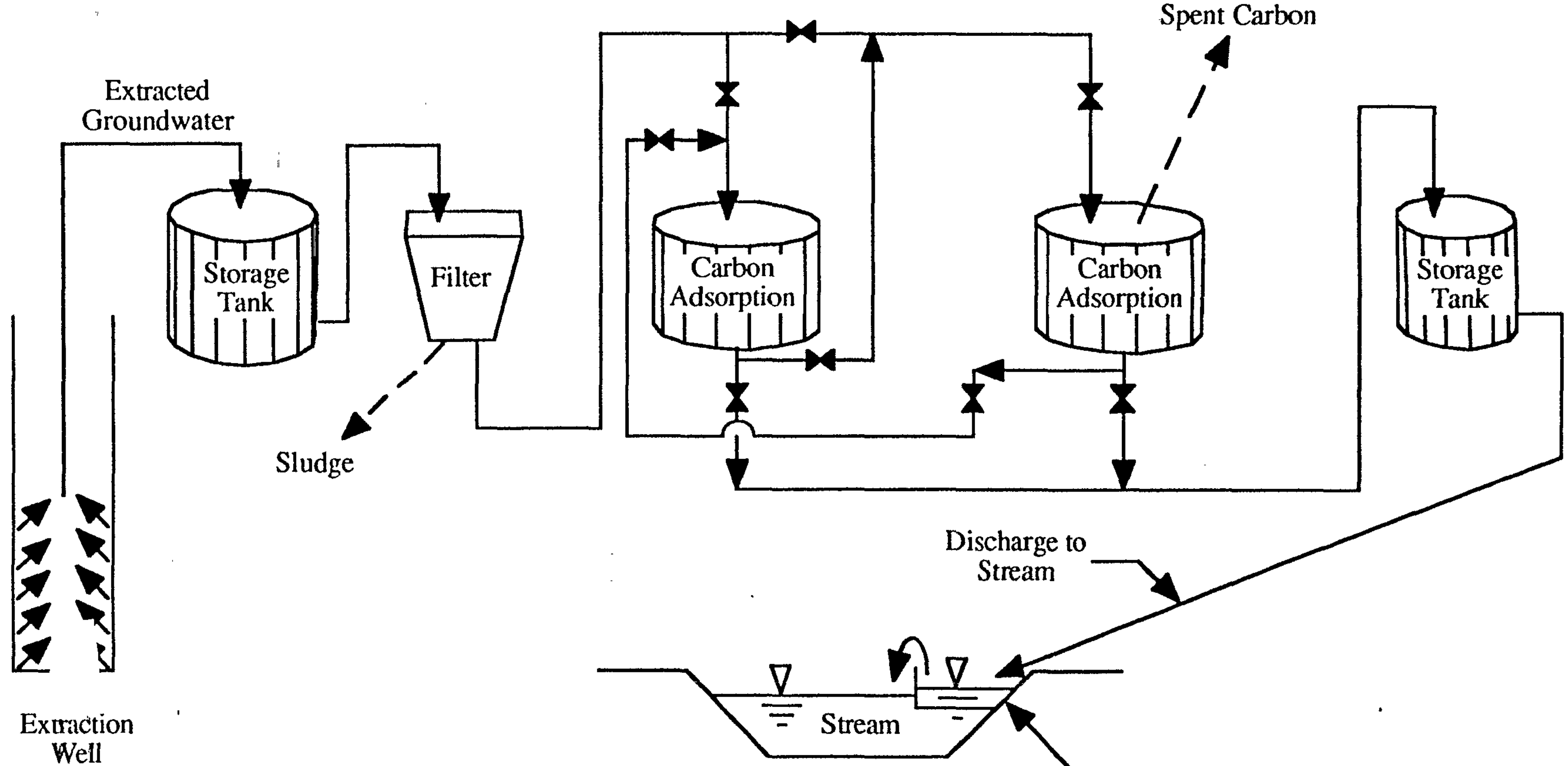

FIGURE 4-10
BERKS SAND PIT
GENERALIZED PROCESS DIAGRAM FOR RAA NO. 5

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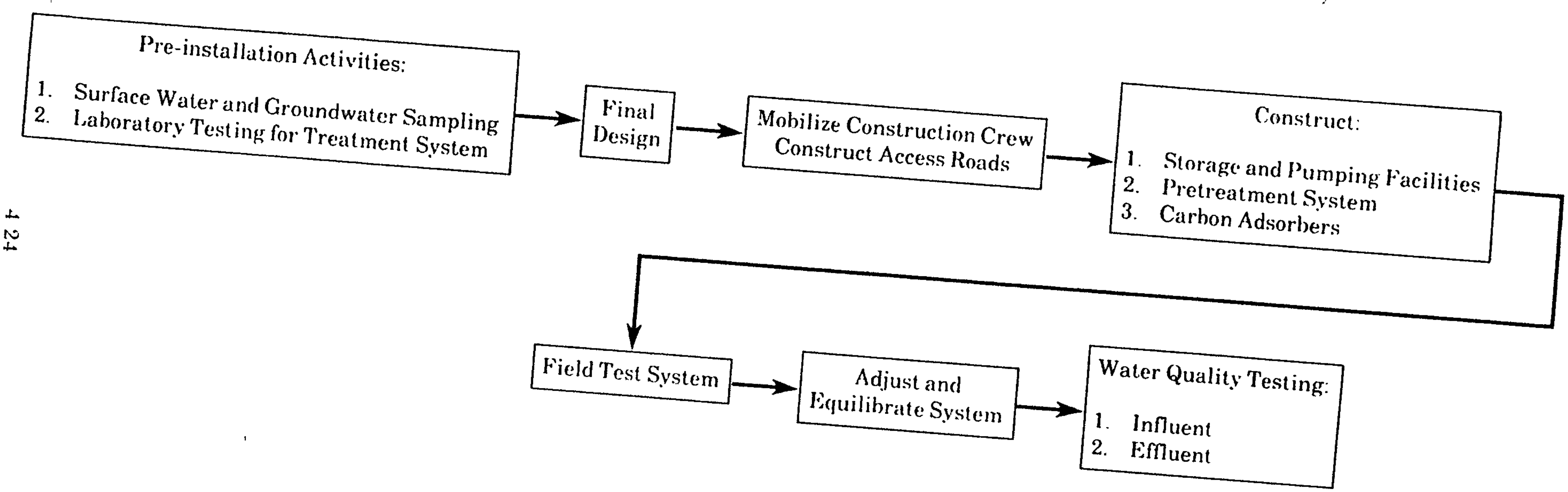

Figure 4-11

EMENTATION PROCEDURE FOR CARBON ADSORPTION TREATMENT SYSTEM

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system. The pretreatment system includes a pressurized diatomaceous earth filter to remove suspended solids so that the pore spaces in the granular activated carbon (GAC) adsorption units do not become clogged with sediment.

The primary component of the treatment system is a series of liquid-phase GAC adsorption units. This system was designed to remove organics from the groundwater, and includes two, 10,000-pound adsorption units in series. It is estimated that the removal efficiency of the carbon units will be greater than 99 percent. The spent carbon from these units will be removed from the site and either disposed of or regenerated. Any option on this system includes adding additional GAC units to provide greater treatment efficiency and to increase protection against system failure. An on-site carbon regeneration system also may be added rather than transporting the carbon off site for regeneration. The final component of the treatment system is a treated water (effluent) storage tank. The storage tank will serve as a reservoir and pumping station from which the treated water will be discharged and was designed to contain a maximum of 12 hours treated effluent volume in the case of a system failure. As with the no action alternative, an environmental review will be conducted every five years.

4.6 Remedial Action Alternative No. 6 - Monitoring, Alternate Water Supply, Groundwater Extraction, Air Stripping with Vapor Phase Carbon Adsorption, Off-Site Treatment and Disposal of Contaminated Sediments, and Reinjection

Implementation of this RAA includes monitoring of the surface water and groundwater quality, construction of an alternate water supply system, installation and operation of a groundwater extraction system to remove contaminants from the aquifer, the construction and operation of an air stripping system and the discharge of the treated water to the aquifer by injection wells. Contaminated sediments will be excavated and transported off site for treatment by incineration and disposal. The major facets of this alternative are described in Sections 4.1 to 4.5 except for the reinjection system which will be described below. A generalized process diagram illustrating the major components of this system is shown in Figure 4-12 and design details for the reinjection are given in Appendix A.

Additional activities such as those described in Section 4.4 also should be conducted for this alternative. Activities specific to the injection system include:

- Water quality sampling

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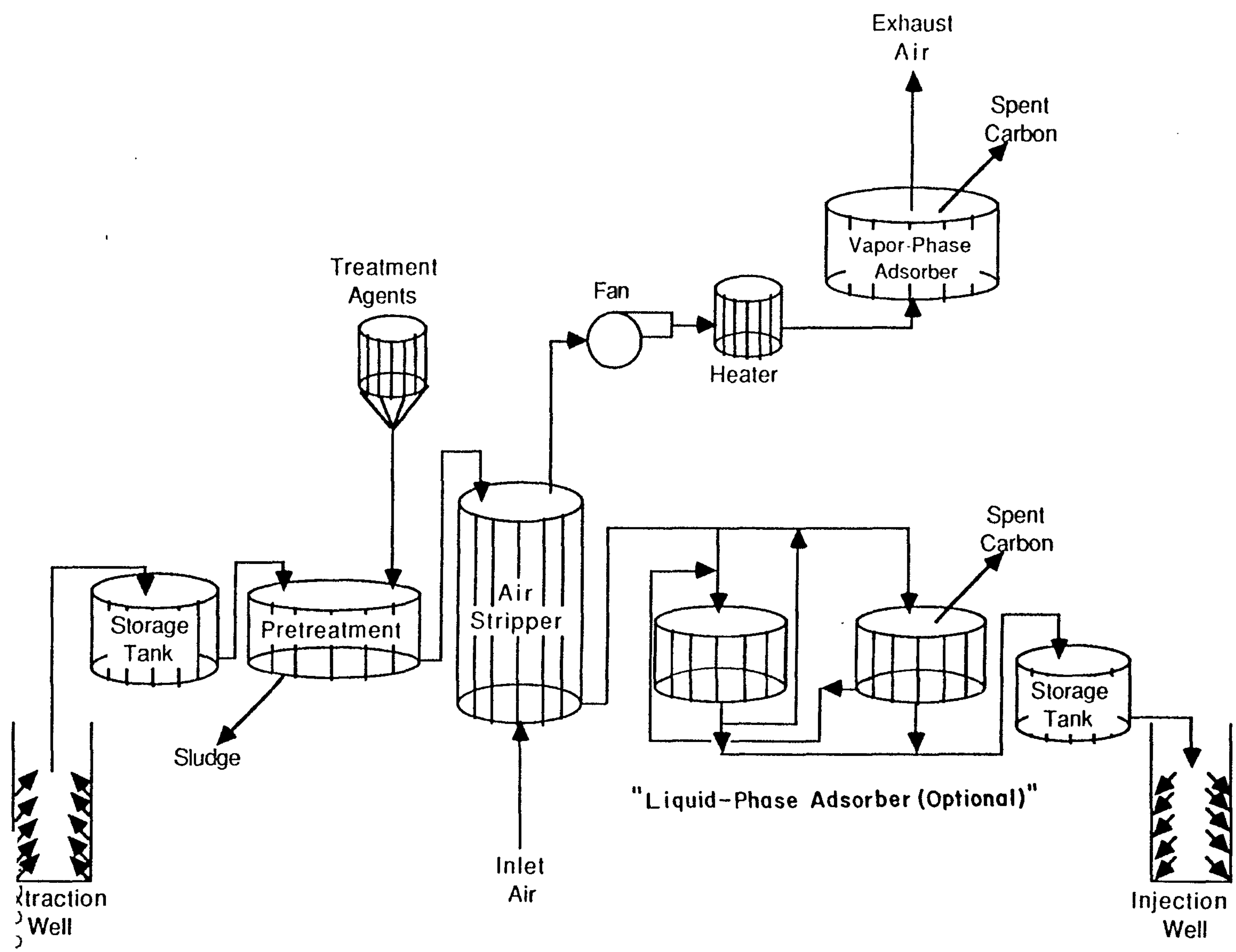

FIGURE 4-12

BERKS SAND PIT
GENERALIZED PROCE[S]S DESIGN FOR RAA NO. 6

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- Short and long-term pump testing
- Analysis of potential for induced fracturing

A groundwater injection system was designed primarily for the disposal of treated groundwater and is used in this alternative as a substitute for discharging treated water to local streams. Three secondary objectives may be associated with the implementation of this alternative: (1) using the injection system to flush contaminants out of the aquifer; (2) using the injection fluids to create vertical, upward gradients to retard the downward movement of contamination; and (3) using the injection system as a means of recharge to maintain the existing groundwater level in the aquifer. Due to the complexity of the hydrologic system, the secondary objectives were given only general consideration in the injection system design. Figure 4-13 illustrates a generalized implementation procedure for the injection well system.

The groundwater injection system design specifies 10 injection wells spaced 200 feet apart along an arc of approximately 800 feet in diameter. Figure 4-14 shows the construction details for the injection wells. Drawing 4 shows some possible locations for the injection wells. The design calculations (see Appendix A) indicate the use of five injection wells each with 250 feet of screen. The number of wells was doubled to 10, based on reports that injection wells need twice as much screen as extraction wells pumping at the same rate (1). The areal configuration was chosen to limit interference and head build-up between wells thereby using the maximum injection capacity for each well. Since there is the potential for the injection wells to influence the groundwater gradient, an arcuate configuration was used to increase the gradient towards the extraction wells. This configuration is intended to flush contaminants upward and towards the extraction wells while providing sufficient disposal capacity.

The 10 injection wells were designed to be 500 feet deep with 250 feet of screen each. The injection capacity of these wells is estimated to be 17.5 gpm each; a capacity equivalent to the pumping wells. Recharge into the aquifer is fed by gravitational forces proportional to the head build-up in the injection well. Many of the assumptions applicable to the groundwater extraction system also are applicable to the pumping system.

It should be noted that these are not final designs and are subject to modification. The final design of the injection system should be based on further field studies. Variations of certain design parameters should also be considered. For example, doubling the diameter of each

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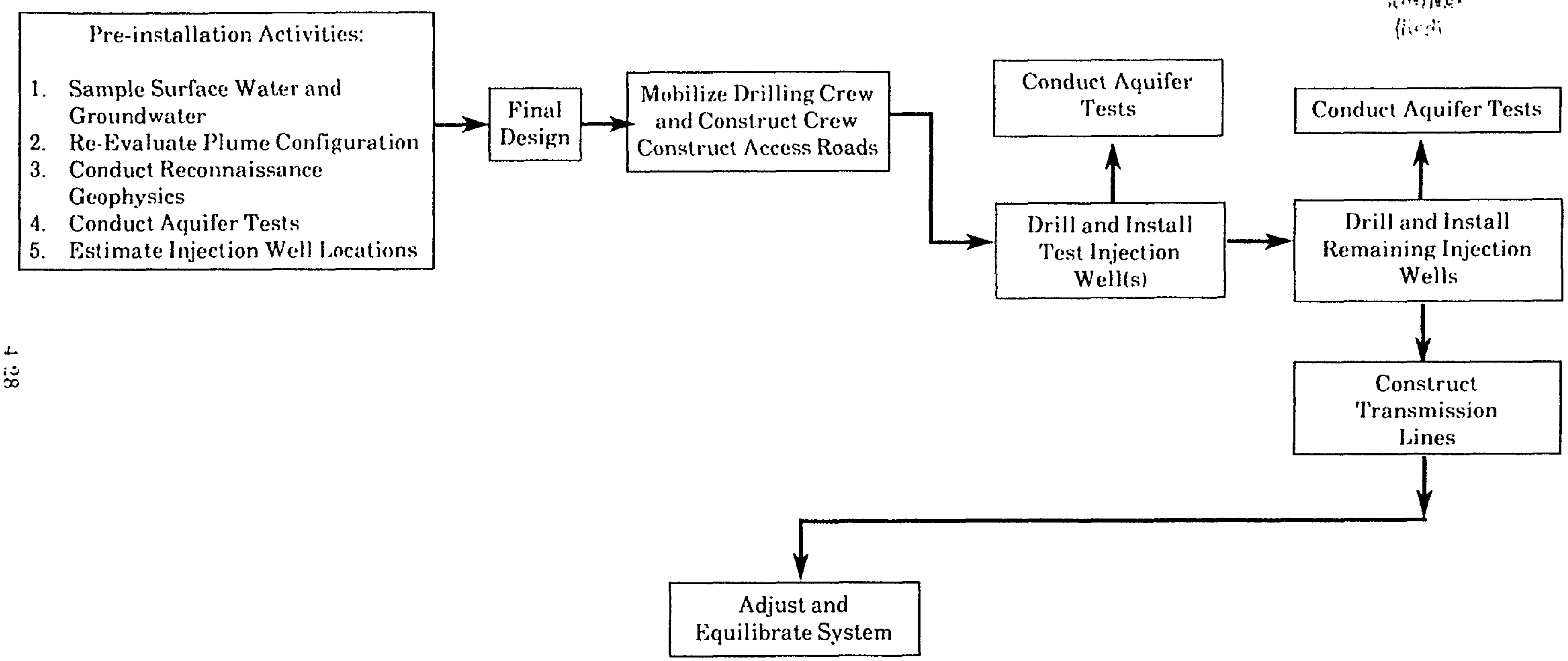

Figure 4-13

GENERALIZED IMPLEMENTATION PROCEDURE FOR INJECTION WELL SYSTEM (RAA NO. 6 - RAA NO. 7)

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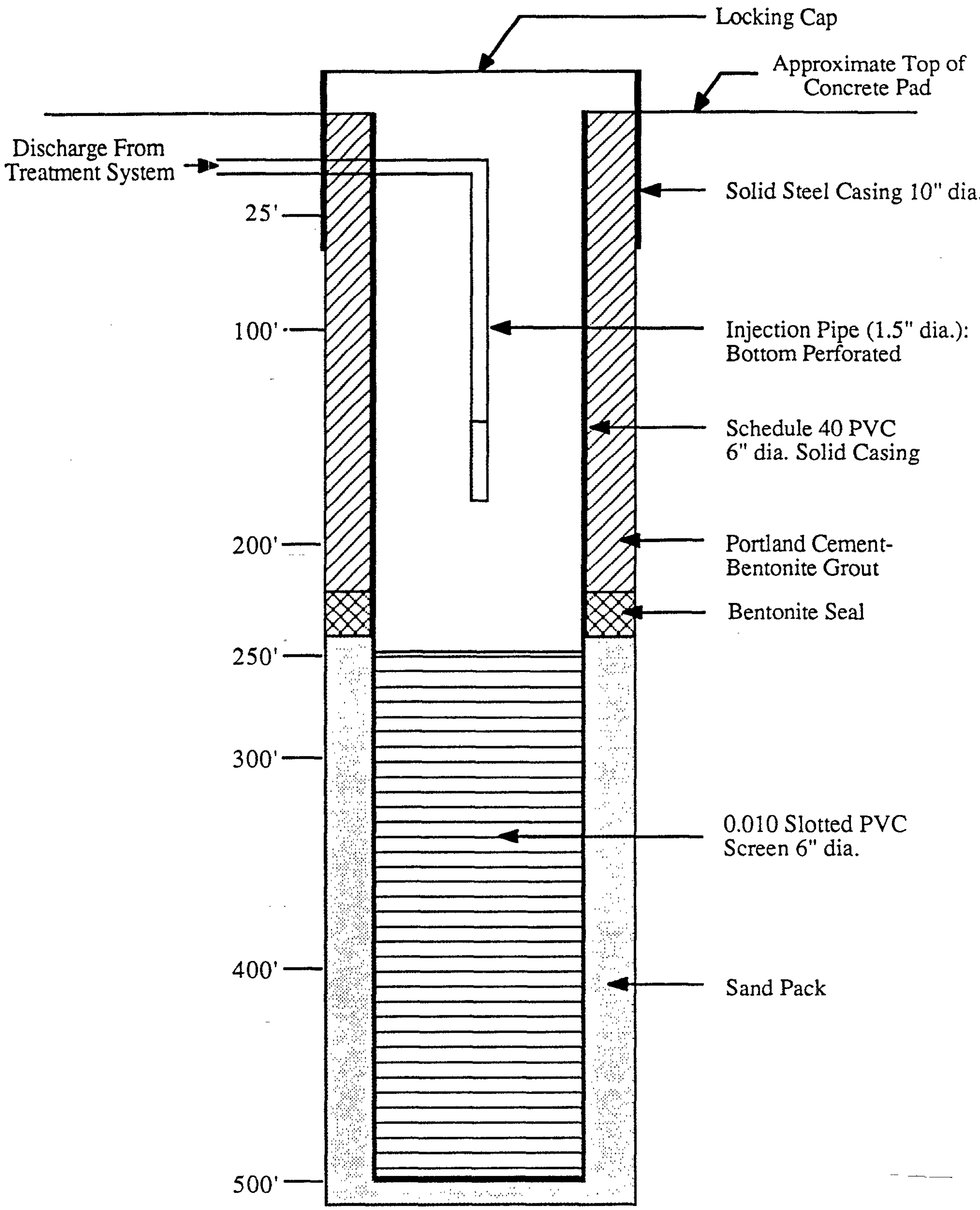

FIGURE 4-14

BERKS SAND PIT

CONSTRUCTION DETAILS FOR A TYPICAL INJECTION WELL

AR300866

well rather than doubling the number of wells may be an effective method of increasing the screen area and reducing costs.

As under the no action alternative, an environmental review will be conducted every five years.

4.7 Remedial Action Alternative No. 7 - Monitoring, Alternate Water Supply, Groundwater Extraction, Liquid-Phase Carbon Adsorption, Off-Site Treatment and Disposal of Contaminated Sediments, and Reinjection

Implementation of this RAA includes monitoring of the surface water and groundwater quality, construction of an alternate water supply system, installation and operation of a groundwater extraction system to remove contaminants from the aquifer, the construction and operation of a liquid-phase carbon adsorption treatment system and the discharge of the treated water to the aquifer by injection wells. Contaminated sediments will be excavated and transported off site for treatment by incineration and disposal The major facets of this alternative were previously described in Sections 4.1 to 4.6. A generalized process diagram showing the major components of this alternative is given in Figure 4-15.

As under the no action alternative, an environmental review will be conducted every five years.

4.8 Screening of Remedial Action Alternatives

Seven remedial action alternatives were screened with respect to effectiveness, implementability, and cost to determine which alternatives should be retained for detailed evaluation. Detailed descriptions of the seven alternatives are presented in Sections 4.1 to 4.7.

All seven of the remedial action alternatives were determined to be implementable and cost effective. RAA No. 4 through RAA No. 7 also were found to be effective in protecting human health and the environment. These four RAAs (4 to 7) will be retained for detailed evaluation.

RAA No. 1 through No. 3 are not necessarily effective in protecting human health and the environment. However, these three alternatives will be retained for detailed evaluation because:

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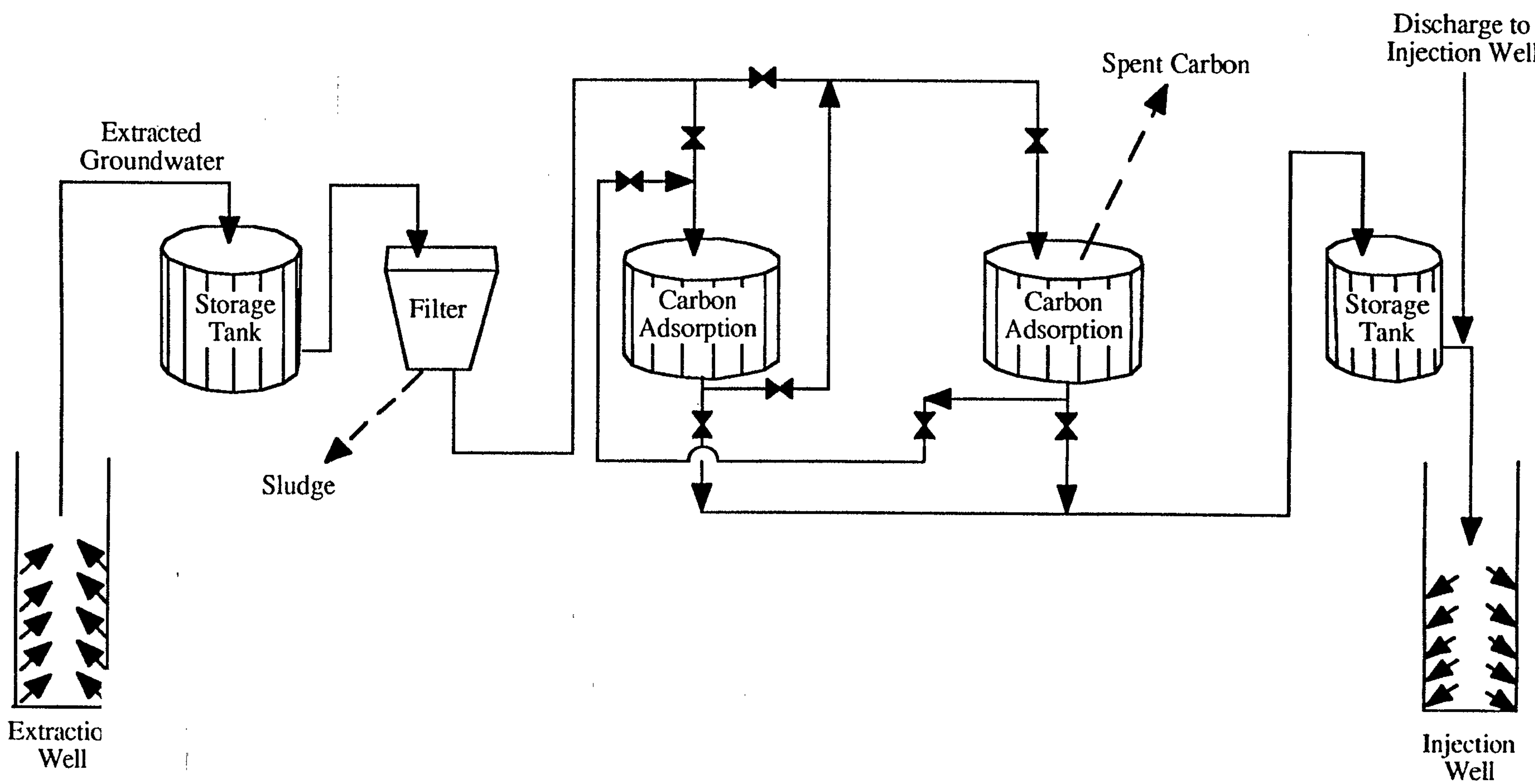

FIGURE 4-15

BERKS SAND PIT

GENERALIZED PROCESS DIAGRAM FOR RAA NO.7

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- RAA No. 1, the no action alternative, is required for consideration by NCP.
- RAA Nos. 1, 2 and 3 may be used to provide baseline costs with which the other alternatives may be compared.

Therefore, all seven remedial action alternatives will be retained for detailed evaluation.

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EVALUATION OF ALTERNATIVES

5.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

5.1 Evaluation Criteria

In this chapter, each remedial action alternative (RAA) is evaluated with respect to cost and non-cost criteria. Non-cost criteria include compliance with Applicable or Relevant and Appropriate Requirements (ARARs); reduction of toxicity, mobility and/or volume; short-term effectiveness, long-term effectiveness and performance; implementability; community and state acceptance; and overall protection of human health and the environment. Cost criteria include capital costs, operation and maintenance costs, and present-worth or net present value costs. These criteria are used to evaluate the technologies that make up each remedial action alternative and to provide a basis for comparison between alternatives.

A brief description of each of these nine evaluation criteria follows.

5.1.1 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion assesses the ability of each RAA to comply with ARARs. Each alternative will be evaluated with respect to: 1) contaminant-specific ARARs such as maximum contaminant levels (MCLs); 2) location-specific ARARs; and 3) action-specific ARARs such as OSHA regulations, RCRA requirements, etc. Table 3-1 lists the known contaminant-specific ARARs.

5.1.2 Reduction of Toxicity, Mobility or Volume

This category describes the effect of each remedial action alternative on the mobility, toxicity, and volume of the selected contaminants. Each treatment process and groundwater extraction system has a different effect on each contaminant.

5.1.3 Short-Term Effectiveness

The third evaluation criterion is short-term effectiveness. The short-term effectiveness of an alternative includes the reduction in the magnitude of existing risks, possible short-term risks created by the implementation of the RAA to the community, worker, and/or the environment, and the time until full protection is achieved.

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5.1.4 Long-Term Effectiveness and Permanence

This evaluation criterion considers the long-term effectiveness and permanence of each RAA. This criterion includes risks remaining after implementation of an RAA, long-term reliability and potential need for replacement. Also included are long-term management responsibilities such as operation and maintenance and monitoring.

5.1.5 Implementability

The fifth evaluation criterion is implementability. This criterion includes consideration of the difficulty with which an RAA may be constructed and the availability of requisite equipment and specialists. The operational reliability, availability of treatment, storage and disposal facilities, and coordination with other agencies or offices also will be addressed.

5.1.6 Community Acceptance

The acceptance or opposition of community members to each RAA will be included in this evaluation.

5.1.7 State Acceptance

The acceptance or opposition of the state Department of Environmental Resources to each RAA will be discussed in this evaluation.

5.1.8 Cost

The cost evaluation for each RAA includes assessment of capital costs, operation and maintenance costs, and net present value of capital and operation and maintenance costs. Detailed supporting data for the cost estimates are provided in Appendix A with the sensitivity analysis included in Appendix B.

The remedial design quantities generated for this Feasibility Study (FS) are based on data compiled during the Remedial Investigation (RI). The objective of the RI was to identify site contaminants, and to assess the corresponding potential health and environmental risks. As such, the data base required to prepare detailed construction cost estimates were not fully

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developed. Therefore, the cost estimates in this FS are presented as a range of values that reflect the sensitivity of remediation costs and quantities developed from the RI data base. Potential variability in the present worth costs were evaluated for each RAA using a sensitivity analysis. To perform the sensitivity analyses, capital and operation and maintenance costs for each RAA were classified as sensitive or non-sensitive to cost variability.

Non-sensitive costs were identified as those items whose quantity and unit costs were known with relative certainty. In general, this included only those items whose quantities and unit costs were established by vendor quotes or by Means - 1988 Cost Data Handbooks for electrical, site work, mechanical, and building construction systems. These items are referenced on the capital and operation and maintenance cost spreadsheets for each alternative. Sensitive costs included those items whose quantity or unit cost were assumed for a technology and therefore are most likely to change.

A range of potential variability in the cost for an RAA was established by applying sensitivity factors of 0.5, 1.0, 1.5, and 2.0 to the total RAA sensitive (unit) costs. These sensitivity factors respectively represent a 50 percent decrease, no change, a 50 percent increase, and a 100 percent increase in the RAA sensitive capital plus sensitive operation and maintenance costs.

In addition to applying the above sensitivity factors, the sensitivity analyses also evaluated a range of costs for the following items:

- Indirect contractor costs
- Health and safety costs
- Contingency costs
- Engineering costs

Each of these items was assigned a low and high value to establish a range of costs based on the originally estimated cost of the item. These cost variations were included for each sensitivity factor. The values used to vary these items are shown in Table 5-1.

When combined, the cost variations produce a three by four sensitivity matrix of 12 present worth costs for each RAA. All present worth costs were based on a 10 percent interest rate with a 30-year duration. It was assumed that some of the technologies would require

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Table 5-1

BERKS SAND PIT SITE
SENSITIVITY ANALYSIS COST FACTOR VARIATION

Cost Factor	Low	Expected	High
Subcontractors' Work, expressed as percentage of Total Capital Cost	10%	20%	30%
Indirect Contractor Costs, expressed as percentage of Total Direct Cost adjusted for location	20%	35%	70%
Health and Safety Costs, expressed as percentage of Total Field Cost(1)	3%	5%	10%
Capital Contingency Cost, expressed as percentage of Total Field Cost(1)	10%	20%	30%
O&M Contingency Cost, expressed as percentage of O&M Cost adjusted for location	10%	20%	30%
Engineering Cost, expressed as percentage of Total Field Cost(1)	5%	10%	20%

(1) (Total Field Cost) = (Total Direct Cost adjusted for location) + (Indirect Contractor Cost) + (Contractor Profit)

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decommissioning at the 30th year and a sinking fund was included to annualize these costs. The decommissioning costs were assumed to be equal to the total adjusted capital costs to be incurred in the 30th year. The sensitivity analyses include an adjustment to the sinking fund cost of an RAA to account for those technologies within the RAA that will not have an associated cost for decommissioning (i.e., the alternate water supply system and the excavation of seeps). A general sensitivity matrix is shown in Table 5-2, which indicates the locations for the lowest, highest, and original RAA cost estimates.

5.1.9 Overall Protection of Human Health and the Environment

This evaluation criterion provides a summary of the overall protection of human health and the environment provided by each RAA.

5.1.10 Summary of Results

Table 5-3 represents a brief summary of the results of the alternative evaluations for each of the nine criteria identified in Section 5.1.

5.2 Remedial Action Alternative No. 1

Implementation of this RAA satisfies cleanup category 1: No action. The no action alternative does not include any provisions for remedial action at the Berks Sand Pit Site, although this alternative does include provisions for continued monitoring of the groundwater and surface water. No additional monitoring points will be added to those that are already established at the site. The principal components of this alternative are:

- No remedial action
- Continued surface water and groundwater monitoring

5.2.1 Compliance with ARARs

The contaminant-specific ARARs, as defined in Section 3.4.3 for human health and the environment, would not be met under this alternative. These ARARs will not be met because no remedial action will be implemented. No location-specific ARARs were identified. The monitoring program described in this RAA will include compliance with action-specific ARARs such as OSHA regulations and a site-specific health and safety plan.

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Table 5-2

BERKS SAND PIT SITE
GENERAL SENSITIVITY ANALYSIS MATRIX
(PRESENT WORTH)

Cost Factors	Sensitivity Factors[1]			
	0.5	1.0	1.5	2.0
Low	Lowest Expected Cost	-	-	-
Original	-	Original Cost	-	-
High	-	-	-	Highest Expected Cost

(1) Applied to assumed unit cost factors only.

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Table 5-3

BERKS SAND PIT
SUMMARY OF THE ALTERNATIVE EVALUATIONS

Alternative	ARAR Compliance	Toxicity, Mobility or Volume Reduction	Short Term Effectiveness	Long Term Effectiveness and Performance	Implementability	Community Acceptance	State Acceptance	Present Worth Cost ($1000)	Protection of Human Health and Environment
RAA 1 No Remedial Action	Does not comply with contaminant-specific ARARs	Does not reduce toxicity, mobility or volume	Does not reduce risks	Does not reduce risks	Easily implementable	Probably unacceptable	Probably unacceptable	902.6	Non-protective
RAA 2 No Remedial Action with Groundwater Monitoring	Does not comply with contaminant-specific ARARs	Does not reduce toxicity, mobility or volume	Does not reduce risks	Does not reduce risks	Easily implementable	Probably unacceptable	Probably unacceptable	2,299.0	Non-protective
RAA 3 Alternate Water Supply with Groundwater Monitorirng	Does not comply with contaminant-specific ARARs	Does not reduce toxicity, mobility or volume	Reduces only a portion of the health risks	Reduces only a portion of the health risks	Easily implementable	Favorable acceptance	Probably unacceptable	3,969.7	Partially protective
RAA 4 (Air Stripping) Alternate Water Supply, Sediment and Ground-water Treatment, Disposal to Stream	Complies with known ARARs	Volume reduced, mobility reduced, toxicity reduced	Reduces risks to public health	Reduces most of the risks	Implementable	Favorable acceptance	Favorable acceptance	13,179.6	Protective
RAA 5 Alternate Water Supply, Sediment and Ground-water Treatment, [illegible] Adsorption, [illegible] Disposal	Complies with known ARARs	Volume reduced, mobility reduced, toxicity reduced	Reduces risks to public health	Reduces most of the risks	Implementable	Favorable acceptance	Favorable acceptance	13,723.9	Protective

ORIGINAL
(Red)

AR300877

Table 5-3 (Continued)

BERKS SAND PIT
SUMMARY OF THE ALTERNATIVE EVALUATIONS

ORIGINAL (Red)

Alternative	ARAR Compliance	Toxicity, Mobility or Volume Reduction	Short-Term Effectiveness	Long-Term Effectiveness and Performance	Implementability	Community Acceptance	State Acceptance	Present Worth Cost ($1000)	Protection of Human Health and Environment
RAA 6 Alternate Water Supply, Sediment and Ground-water Treatment, Air Stripping, Reinjection	Complies with known ARARs	Volume reduced, mobility reduced, toxicity reduced	Reduces risks to public health and environment	Reduces most of the risks	Implementable	Favorable acceptance	Favorable acceptance	14,218.6	Protective
RAA 7 Alternate Water Supply, Sediment and Ground-water Treatment, Carbon Adsorption, Reinjection	Complies with known ARARs	Volume reduced, mobility reduced, toxicity reduced	Reduces risks to public health and environment	Reduces most of the risks	Implementable	Favorable acceptance	Favorable acceptance	14,762.9	Protective

AR300878

Original (Red)

5.2.2 Reduction of Toxicity, Mobility or Volume

There is no reduction of contaminant toxicity, mobility or volume under this alternative. No treatment options are included in this RAA, hence no contaminated materials are treated or destroyed and no treatment residuals are produced.

5.2.3 Short-Term Effectiveness

The no action alternative will not reduce the potential public health and environmental risks as defined in the "Public Health Evaluation and Environmental Concerns" section contained in the RI. The two complete exposure pathways identified in the RI were the groundwater exposure pathway via inhalation, ingestion, and dermal contact by receptors on residential wells, and the surface water/sediment exposure pathway via ingestion and dermal contact by receptors using these areas (e.g., small children). In addition, environmental degradation would continue in the form of contaminant plume migration and releases to surface waters and sediments.

The Public Health Evaluation in the RI did not account for the four residential households that currently receive water from the Longswamp Township Well Association (Superfund) well. While for the four residential households the actual potential public health risk is now reduced and the groundwater exposure pathway, as defined above, is now incomplete, the presence of 1,1-dichloroethene (DCE) and 1,1,1-trichloroethane (TCA) concentrations in excess of ARARs in other groundwater samples would indicate that potential public health risks are still present to the other residential households (see RI for complete discussion).

The no action alternative, while not proposing the implementation of a remedial alternative measure at the Berks Sand Pit Site, already contains a temporary, limited emergency action that has reduced the potential public health risk to a limited number of receptors.

Periodic sampling of monitoring and residential wells and surface water sampling points will result in a minimal acute exposure of sampling personnel to site contaminants via inhalation and dermal contact with groundwater, surface waters, and sediments. Exposure would be intermittent and of short duration. Generally, this type of exposure is readily controlled to within acceptable limits using conventional health and safety techniques.

AR300879

Full protection to human health and the environment is not achieved by this alternative.

5.2.4 Long-Term Effectiveness

There is no long-term reduction in risk to human health or the environment associated with this RAA. The long-term risks associated with this alternative are similar to those described in Section 5.2.3. Additionally, contaminated materials may migrate off site thereby posing increased risk to new receptors.

Long-term management of this RAA includes the scheduling of sampling events and subsequent evaluation of analytical results. As no remedial action is to be taken, engineering reliability is not an applicable evaluation criterion. However, site evaluations may suggest the need for some type of future remedial actions.

5.2.5 Implementability

The only technologies applied by this RAA are those associated with media sampling and subsequent laboratory analyses. Procedures for these activities are well documented and there appears to be no technical restrictions on the implementation of this RAA.

Continued risks to the environment may make interaction with other agencies or offices desirable although approval or permits are not expected to be necessary.

5.2.6 Community Acceptance

The public perception of this alternative may not be satisfactory since the contaminants remain on site and probably will continue to reduce the water quality of some of the residential wells still in use. Alternate water supplies are not readily available so the residents face a real dilemma if their potable water supply is affected.

5.2.7 State Environmental Agency Acceptance

It is doubtful that the state would accept a no action alternative since a public health and environmental risk has been found to exist: a no action alternative would not reduce the known risks.

AR300880

ORIGINAL (Red)

5.2.8 Cost

Supporting data for the cost evaluation for the no action alternative are presented in Appendix A. There are no capital costs associated with this alternative. There are annual costs incurred for sampling, analysis, and data management (see Tables 5-4 and 5-5). The capital, operation and maintenance, and present worth costs are presented in Table 5-4.

The annual operation and maintenance cost for the no action alternative will be approximately $95,748. The total present worth costs for this alternative, assuming a 30-year project life, is approximately $902,608.

5.2.9 Overall Protection of Human Health and the Environment

This RAA does not meet CERCLA goals because contaminant migration is not inhibited and contaminant toxicity, mobility or volume is not reduced. This RAA does not reduce existing or future potential risks to human health or the environment.

5.3 <u>Remedial Action Alternative No. 2</u>

This no action with monitoring alternative fulfills the requirements of cleanup Category I but is based on the installation of additional wells to expand the monitoring system that is used with RAA No. 1. The major components of this alternative are:

- Continue surface water and groundwater monitoring.
- Expansion of existing monitoring system.

5.3.1 Compliance with ARARs

The contaminant-specific ARARs, as defined in Section 3.4.3, would not be met under this alternative as no cleanup actions will be implemented. No location-specific ARARs were identified. The monitoring program described by this RAA will include compliance with action-specific ARARs such as OSHA regulations, a site-specific health and safety plan and regulations governing transportation and disposal of drill cuttings.

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Table 5-4

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 1[1]

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
No Action	$0	$95,748	$902,608	$902,608
Total	0	95,748	902,608	902,608

[1] Costs presented in 1988 dollars.

AR300882

ORIGINAL

Table 5-5

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 1[1]

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$669.0	$827.4	$ 985.8	$1,144.2
Original	729.8	902.6	1,075.4	1,248.2
High	790.6	977 8	1,165.0	1,352.2

[1] Costs presented in 1988 dollars.

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5.3.2 Reduction of Toxicity, Mobility or Volume

There is no reduction of toxicity, mobility or volume under this alternative. No treatment options are included in this RAA, hence no contaminated materials are treated or destroyed and no treatment residuals are produced.

5.3.3 Short-Term Effectiveness

The monitoring alternative will not reduce the potential public health and environmental risks as defined in the RI and as discussed in the no action alternative, Section 5.2.3. The expansion of the monitoring program for residential and monitoring wells and surface water sampling points will serve two important public health functions. First, it will increase the database for a temporal and spatial trend analysis in the vicinity of the Berks Sand Pit Site as well as off site. This analysis would indicate whether the potential public health and environmental risks are increasing or decreasing over time. Second, the monitoring program would serve as an early warning system for those residential households that are currently using groundwater that has concentrations of contaminants below the ARARs for domestic use. The observation of an increasing trend in concentrations of contaminants would enable additional emergency actions to be taken or other remedial alternatives to be pursued. The expanded program will provide more human and environmental exposure point concentrations for inclusion in additional exposure pathway analyses, if necessary.

In addition to the minimal acute exposures by sampling personnel discussed in the no action alternative, this alternative would involve minimal acute exposures by the drilling crew and minimal environmental degradation due to construction of access roads and the drilling activities themselves. As was previously discussed, this type of exposure is readily controlled within acceptable limits using conventional health and safety techniques, as well as standard environmental safeguards.

The monitoring alternative would maintain the potential human health and environmental risk level as defined in the RI with the exception of a reduction in risk to the Superfund well users. It could potentially prevent an increase in public health risk to current residential well users via the early warning component of the expanded monitoring program. However, full protection of human health and the environment is not achieved with this RAA.

AR300884

5.3.4 Long-Term Effectiveness

There is no long-term reduction in risk to human health or the environment associated with this RAA. The long-term risks are similar to those described in Section 5.2.4 for the no action alternative. However, the expanded monitoring system will fill in various data gaps and will provide information that will be useful in developing a continually updated, dynamic representation of contaminant movement and risk at the site. Long-term monitoring will create the requisite data base from which potential future risks to human health and the environment may be extrapolated.

Long-term management of this RAA includes the scheduling of sampling events and the subsequent evaluation of analytical results. Some maintenance of the monitoring wells such as periodic redevelopment will be required. The monitoring system probably will not need to be replaced, although additional monitoring points may be required to track the contaminant plume over long periods of time and off site, if necessary. Long-term management also will include periodic re-evaluation of the site.

5.3.5 Implementability

The primary activities employed by this RAA include drilling and installation of monitoring wells, sampling and laboratory analysis. All of these activities have been used extensively in defining contaminant distribution and movement and are considered to be easily implemented and reliable over long periods of time. Procedures for these activities also are well documented. There appears to be no technical restrictions on the implementation of this RAA.

Continued risk to the environment may make interaction with other agencies or offices desirable, although approval and/or permits are not expected to be necessary.

5.3.6 Community Acceptance

This alternative would probably be received with negative enthusiasm by the residents still using their own wells as a source for potable water. Although RAA No. 2 provides for a more improved monitoring system over RAA No. 1, it still does not reduce the environmental or public health risk.

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5.3.7 State Acceptance

This alternative does not provide for the reduction of a known health and environmental risk and, therefore, would be unacceptable to the state DER.

5.3.8 Cost

Results of the cost evaluation are presented on Tables 5-6 and 5-7. The supporting data for this analysis is contained in Appendices A and B. The present worth cost for this alternative is approximately $1,453,165 with a capital cost of approximately $845,831 and an annual operation and maintenance cost of approximately $154,151.

5.3.9 Overall Protection of Human Health and the Environment

This RAA does not meet CERCLA goals because contaminant migration is not inhibited and contaminant toxicity, mobility or volume is not reduced. This alternative does not meet contaminant-specific ARARs and does not reduce existing or future potential risks to human health or the environment. However, this alternative may be effective in minimizing a risk increase by being able to supply data on the status of the contaminated groundwater plume.

5.4 <u>Remedial Action Alternative No. 3</u>

Implementation of a continued and expanded surface water and groundwater monitoring system, and an alternate water supply system fulfills the requirements of cleanup Category II: prevention of an increase in risk to human health. The two main elements of this alternative are:

- Continued and expanded surface water and groundwater monitoring.
- Installation of an alternate water supply system.

5.4.1 Compliance with ARARs

The contaminant-specific ARARs, as defined in Section 3.4.3, would not be met under this alternative; no cleanup actions will be implemented. There would be no reduction in potential public health risks associated with the surface water/sediment exposure pathway, and no reduction in environmental degradation from contaminant plume migration and contaminant releases to surface water and sediment. However, the alternate water supply

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Table 5-6

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 2[1]

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
Monitoring	$845,831	$154,151	$1,453,165	$2,298,996
Total	845,831	154,151	1,453,165	2,298,996

[1] Costs Presented in 1988 dollars.

Table 5-7

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 2[1]

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$1,539.6	$1,970.6	$2,401.7	$2,832.8
Original	1,787.1	2,299.0	2,799.9	3,306.3
High	2,219.8	2,863.6	3,507.4	4,151.3

(1) Costs presented in 1988 dollars.

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and monitoring alternative would reduce the potential public health risks associated with the groundwater exposure pathway as defined in the RI.

This RAA will include compliance with action-specific ARARs such as OSHA regulations, a site-specific health and safety plan, regulations governing transportation and disposal of drill cuttings and construction debris and regulations governing water supply construction, treatment and distribution.

No location-specific ARARs were identified for this RAA.

5.4.2 Reduction of Toxicity, Mobility or Volume

There is no reduction of contaminant toxicity, mobility or volume under this RAA. No treatment options are included in this RAA; no contaminated materials are treated or destroyed and no treatment residuals are produced.

5.4.3 Short-Term Effectiveness

The alternate water supply and monitoring alternative will reduce the potential public health risks associated with the groundwater exposure pathway by eliminating this pathway immediately upon completion of the alternate water supply. There would be no reduction in potential public health risks associated with the surface water/sediment exposure pathway, and no reduction in environmental degradation from contaminant plume migration and contaminant releases to surface waters and sediments. In addition to the minimal acute exposures to the sampling personnel and the drilling crew and the minimal environmental degradation due to associated drilling operations discussed in the previous alternative, this alternative will involve minimal environmental degradation due to construction of the water supply system. Standard environmental safeguards will ensure that the degradation is minimal and temporary.

Full protection to human health and the environment is not achieved by this alternative, although this alternative does reduce risks posed by the groundwater exposure pathway.

5.4.4 Long-Term Effectiveness

This alternative will reduce risks associated with the groundwater exposure pathway as long as the alternate water supply system is in operation. However, long-term risks associated

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with the surface water/sediment exposure pathway and further contaminant plume migration will not be reduced.

The technologies associated with this RAA include monitoring and an alternate water supply. Monitoring was discussed previously in Section 5.3. An alternate water supply is a reliable means by which the groundwater exposure pathway may be circumvented and thereby reduce long-term risks to human health. Centralized water supply systems usually are managed by local public water commissions. Long-term management generally includes treatment system operation, water quality monitoring, and general system maintenance (i.e., well maintenance, water-line repairs, etc.). Depending on community growth, the water supply system may need periodic upgrading and expansion.

5.4.5 Implementability

The technologies associated with this alternative include installation of a monitoring system and an alternate water supply system. The implementability of a monitoring system was discussed in Section 5.3.

Implementation of a water supply system relies on standard engineering design and construction methods. There appears to be no constraints on the implementability, constructability, or operability of this technology.

The continued risks not addressed by this alternative may make communication with other offices or agencies desirable, since local authorities probably will share in the financing responsibility of maintaining the water supply system. Consideration also should be given to obtaining property access for the installation of the alternate water supply system.

5.4.6 Community Acceptance

The supply of a consistent source of safe potable water probably would be received favorably by a majority of the residents. The reaction of the downgradient receptors is difficult to assess since the rate of the groundwater plume migration is difficult to assess.

This alternative includes three water supply options as described in Section 4.3. Community acceptance probably will be most favorable towards development of a new well field and least favorable towards expanding the Mt. Village water supply system.

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5.4.7 State Acceptance

This alternative provides for a degree of protection by supplying an alternate water supply that decreases the risk of the residents ingesting the water, therefore, the state would probably accept this alternative. However, this alternative does not address other risks posed by contamination at the site. Hence, overall the state probably would not find this alternative acceptable without modificiations to address all of the risks at the site.

5.4.8 Cost

The alternate water supply system includes three options: installation of a new well field, expansion of the Topton water supply system, and expansion of the Mt. Village water supply system. The capital, operation and maintenance, and present worth costs of each option are given in Table 5-8 and Appendix A. A 30-year planning horizon was used to develop the operation and maintenance and present worth costs.

The new well field option will be used to develop total costs for RAAs No. 3 through No. 7. The estimated present worth cost for RAA No. 3 is $3,969,695 with a capital cost of $1,997,102 and an estimated annual operation and maintenance cost of $209,251.

The sensitivity analysis was performed on only one of the water supply options: the new well field. The results for the sensitivity analyses are given in Table 5-9 and Appendix B.

5.4.9 Overall Protection of Human Health and the Environment

This alternative does not inhibit contaminant movement nor does it reduce the volume of the contaminants. Hence, this alternative does not meet CERCLA goals. This alternative does not meet all of the contaminant-specific ARARs. However, risks posed by the groundwater exposure pathway will be minimized. This alternative also will be effective in minimizing a risk increase by being able to supply data on the status of the contaminated groundwater plume.

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Table 5-8

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 3[1]

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
A. Monitoring	$ 845,831	$154,151	$1,453,165	$2,298,996
Alternate Water Supply System:				
B. New Well Field[2]	1,151,272	55,100	519,427	1,670,699
C. Expand Topton System	1,217,000	0	0	1,217,000
D. Expand Mt. Village System	699,000	0	0	699,000
Total = A + B	$1,997,103	$209,251	$1,972,592	$3,969,695

(1) Costs presented in 1988 dollars.
(2) The new well field option of the alternate water supply system is to develop the total RAA cost for RAA No. 3 through RAA No. 7.

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Table 5-9

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 3[1]
($1,000)

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$2,712.0	$3,321.2	$3,930.3	$4,539.4
Original	3,227.9	3,949.5	4,671.0	5,392.6
High	4,207.1	5,139.2	6,071.2	7,003.3

[1] Costs presented in 1988 dollars.

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5.5 Remedial Action Alternative No. 4

Implementation of this RAA fulfills the requirements of cleanup Category III: meet or exceed ARARs for human health. This alternative also is likely to meet the ARARs for the environment. The implementation of this alternative would serve to remediate the groundwater in the site area, and also to remove contaminated sediments that are located at some of the surface seeps. Individual units of this alternative are listed as follows:

- Continued and expanded surface water and groundwater monitoring.
- Installation of an alternate water supply system.
- Groundwater extraction.
- Groundwater treatment by air stripping with vapor-phase carbon adsorption.
- Discharge of treated water to existing surface water courses.
- Excavation of contaminated sediments, treatment by incineration and disposal.

5.5.1 Compliance with ARARs

The contaminant-specific ARARs described in Section 3.4.3 would be met by combining the various technologies included in this alternative. This RAA also will include compliance with action-specific ARARs such as OSHA regulations, a site-specific health and safety plan, regulations governing transportation and disposal of drill cuttings, construction debris, contaminated sediments, and treatment sludges, water supply treatment and distribution, NPDES permits (if required), and wetlands and floodplains regulations. No location-specific ARARs were identified for this alternative.

5.5.2 Reduction of Toxicity, Mobility or Volume

Remedial Action Alternative No. 4 includes an air stripping technology with vapor-phase carbon adsorption to treat groundwater contaminated with volatile organic compounds. A pretreatment system also is included. This technology, used in conjunction with groundwater extraction will reduce the volume of contaminants in the groundwater. The toxicity and mobility of contaminants present in the aquifer will be reduced by treatment and the extraction system. The exact amount of material to be treated by this system is not known though estimates based on concentration isopleth maps in the Remedial Investigation indicate that approximately 4,450 pounds of TCA and approximately 1,750 pounds of DCE are present at the site and may be removed from the groundwater over a long period of time. The treatment system is designed to operate at over 99 percent treatment efficiency so that a large proportion of this contamination will be removed from the extracted groundwater. One drawback associated with air stripping is that stripped volatile organics are released into the atmosphere. These emissions may be effectively controlled by passing contaminated air from the air stripper through a vapor-phase carbon adsorption system to removê the volatile organics. Residuals of the treatment processes employed (sludges and spent carbon) will not be persistent, toxic, mobile, or bioaccumulate in the local environment after proper disposal (sludges and spent carbon) or regeneration (spent carbon).

As an option, a liquid-phase carbon adsorption system also may be added to the air stripping system. The addition of a liquid-phase carbon adsorption system will increase the level of treatment provided by the overall system and will add an extra degree of protection to human health and the environment against system failure. Residuals of the liquid-phase carbon adsorption system will include some amounts of spent carbon that will not be persistent, toxic, mobile, or bioaccumulate in the local environment after disposal or regeneration.

Contaminated sediments also will be excavated and removed from the site. This alternative includes off-site incineration of the sediments to destroy the volatile organic compounds and subsequent disposal at an approved facility.

5.5.3 Short-Term Effectiveness

The monitoring, alternate water supply, groundwater extraction, treatment (air stripping with vapor-phase carbon adsorption), discharge, and sediment excavation alternative (RAA No. 4) would reduce the potential public health and environmental risks for both of the completed exposure pathways as defined in the RI. However, one new exposure pathway is introduced with this alternative; releases from the discharge of treated groundwater to local surface water bodies. Although chronic in nature, the exposures to public health and the environment are expected to be minimal and controlled by action-specific ARARs protective of human health and environmental resources.

In addition to the minimal acute public health exposures and environmental degradation related to sampling, drilling, and water supply construction discussed in the previous alternatives, this alternative also will involve minimal acute adverse effects. Construction of the groundwater extraction, treatment and discharge systems and excavation of contaminated sediments will involve minimal public health risks and environmental

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degradation. As previously discussed, conventional health and safety techniques and standard environmental safeguards will ensure that the public health risks and environmental degradation are minimal and temporary.

The extraction of groundwater could result in localized environmental degradation, especially during periods of drought conditions. Dewatering of the aquifer could occur resulting in reduced groundwater recharge of area streams, seeps, and springs and a reduction in available soil water for vegetation. This is intentional on a limited basis in that contaminated groundwater discharges to surface waters will be eliminated. Smaller discharge connections from the main discharge pipe could be used to maintain adequate surface water levels and surface soil moistures through a diffused surface soils irrigation system. These discharges also could be used to regulate watershed discharge during periods of low or high stream flow.

With respect to contaminant-specific, location-specific and action-specific ARARs, full protection of human health is achieved upon implementation of this RAA. The ARARs also may be achieved for the environment.

5.5.4 Long-Term Effectiveness

Long-term risks to human health and the environment posed by the site should be minimized after implementation of this RAA.

Long-term management of this alternative will be more complex than for the three alternatives evaluated in Sections 5.2 through 5.4. Management includes those items previously described for the monitoring and alternate water supply technologies. In addition, monitoring and operation and maintenance for the groundwater extraction and groundwater treatment systems will be required. This may include such activities as water quality monitoring of the treatment system influent and effluent, periodic pump maintenance and extraction well redevelopment, cleaning and/or replacement of the air stripper packing material and carbon in the carbon adsorption units as well as periodic evaluation of system performance and the level of contaminant cleanup.

In general, extraction and treatment systems are a reliable means by which groundwater contamination may be remediated. If a routine operations and maintenance schedule is

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followed, these systems should be operable for long periods of time (15 years to 30 years) Replacement of selected wells or mechanical components eventually may be necessary

5.5.5 Implementability

This RAA includes six technologies: groundwater monitoring, alternate water supply, groundwater extraction, groundwater treatment, discharge, and sediment excavation, treatment, and disposal. Monitoring is evaluated in Section 5.3, and the alternate water system is discussed in Section 5.4.

Groundwater extraction has been used extensively in the control and removal of contaminated groundwater. In general, it has been demonstrated that groundwater pumping is both a reliable and effective method of groundwater control. However, the complex hydrogeology at the site may reduce the efficiency of the extraction system. The groundwater extraction system designed for this FS includes a considerable degree of flexibility so that the system may be adjusted for maximum efficiency. The flexibility comes from well placement and construction and the ability to adjust pumping rates to achieve the desired zones of influence. The extraction well system was designed to use well clusters with the wells in each cluster being completed to different depths. The reason for this is two-fold: (1) well clusters will provide better control and flexibility over the removal of vertically distributed contaminants and; (2) having multiple wells pumping "at the same point" reduces the risks of system failure.

Construction of the groundwater extraction system will utilize standard equipment and procedures, and no construction difficulties are expected. Numerous ancillary activities, in addition to drilling, well installation and development, such as geophysics and aquifer testing also are included with this technology. These activities are expected to increase the implementability of an efficient system.

An air stripping treatment system with vapor-phase carbon adsorption also is part of this RAA. This system includes, in addition to an air stripper, a pretreatment system and a liquid and/or vapor-phase carbon adsorption unit. Air stripping, as the primary treatment system, is an extensively-used technology that has been shown to be a reliable and effective method in the treatment of water contaminated with volatile organic compounds.

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This treatment system also provides for flexibility and ease of construction. In fact, pre-designed, modular air stripping systems are available. The use of pre-designed systems is desirable because design and construction costs are minimized, and the performance of a system, particularly efficiency and operation and maintenance, under field conditions is well documented. The air stripping treatment system also was designed to handle considerable variation in flow rates and concentrations. Not only is the air stripper itself flexible, various components such as a pretreatment storage tank have been included to keep the system operating efficiently and to provide storage in case of air stripper failure.

Vapor and/or liquid-phase carbon adsorption systems may be added as separate components of this overall treatment system. The implementability of carbon adsorption systems is discussed in detail in Section 5.6.5.

A discharge system also is included as part of this RAA. The discharge system was designed to be a simple, point discharge to a nearby stream. This technology has been extensively applied and is reliable and easy to implement. The primary concerns associated with the discharge system are the quantity and quality of the discharge water. The discharge water quantity and quality may be adjusted so as to minimize the impact on the stream in accordance with NPDES requirements.

This RAA also includes provisions for the excavation, off-site treatment by incineration and subsequent disposal of contaminated sediments at a RCRA-approved facility. This technology should reduce the risks to human health by limiting the dermal contact exposure pathway. As with other technologies included in this RAA, excavation and off-site treatment/disposal is an easily implemented and reliable technology.

Overall, this RAA includes technologies that are all relatively easy to implement. Further, all of these technologies have been demonstrated to be reliable and effective for their respective purpose. Efficient implementation of all technologies included in this alternative will require strong management organization and planning, as well as good communication between government agencies/offices, the contractors and the public. Coordination will be necessary to obtain requisite permits such as NPDES permits. All technologies associated with this RAA, and the RAA as a whole, are effective and implementable.

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5.5.6 Community Acceptance

A favorable public reaction to this alternative probably could be expected since it concerns all of the problems encountered at the site. Some of the residents may be affected by the proposed construction and the daily operations of the treatment system, although these disruptions should be minor. Many of the existing residential wells may be no longer usable since the groundwater pumping may lower the groundwater table below some of the wells. However, an alternate source of potable water will be supplied so this should not be a problem.

5.5.7 State Acceptance

This alternative addresses and compiles with most state ARARs, and the original objectives that prompted this study. The volume and mobility of the contaminants are minimized. Hence, the state probably will find this RAA acceptable.

5.5.8 Cost

Tables 5-10 and 5-11 contain the results of the cost evaluation which list the capital, annual operation and maintenance, and present worth costs for this alternative. The present worth cost of this alternative is approximately $13,179,620 with a total capital cost of approximately $5,177,985 and an annual operation and maintenance cost of approximately $848,808.

Costs also were developed for this alternative including an optional liquid-phase carbon adsorption system. These capital, operation and maintenance, and present worth costs, are developed in Appendix A and are given in Table 5-10.

5.5.9 Overall Protection of Human Health and the Environment

This alternative is designed to control and reduce the volume of contaminants at the site and, therefore, it meets CERCLA goals. This alternative also satisfies all ARARs for human health and may satisfy the ARARs for the environment.

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Table 5-10

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 4(1)

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
A. Monitoring	$ 845,831	$154,151	$1,453,165	$ 2,298,996
Alternate Water Supply System:				
B. New Well Field(2)	1,151,272	55,100	519,427	1,670,699
C. Expand Topton System	1,217,000	0	0	1,217,000
D. Expand Mt. Village System	699,000	0	0	699,000
E. Groundwater Extraction System	1,490,373	176,019	1,659,312	3,149,685
F. Air Stripping Treatment System	902,336	104,390	984,079	1,886,415
G. Air Stripping with Vapor-Phase Carbon Adsorption(2)	1,161,984	424,934	4,005,815	5,167,799
H. Air Stripping with Liquid- and Vapor-Phase Carbon Adsorption	1,761,884	519,394	4,896,315	6,658,199
I. Excavation, Treatment and Disposal of Sediments	47,863	0	0	47,863
J. Discharge to Stream	480,662	38,604	363,916	844,578
Total = A+B+E+G+I+J	$5,177,985	$848,808	$8,001,635	$13,179,620

(1) Costs presented in 1988 dollars.
(2) The new well field option of the alternate water supply system and the air stripping with vapor-phase carbon adsorption option of the treatment system were used to develop the total RAA cost.

AR300900

Table 5-11

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 4[1]
($1,000)

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$ 9,991.3	$11,253.7	$12,516.2	$13,778.6
Original	11,639.4	13,143.7	14,648.0	16,152.3
High	14,560.1	16,524.8	18,489.5	20,454.2

[1] Costs presented in 1988 dollars.

AR300901

5.6 Remedial Action Alternative No. 5

This alternative is similar to RAA No. 4 except that carbon adsorption units are used instead of an air stripping tower to treat the groundwater. A list of the component technologies included in this alternative follows:

- Continued and expanded surface water and groundwater monitoring
- Installation of an alternate water supply system
- Groundwater extraction
- Groundwater treatment by carbon adsorption
- Excavation of contaminated sediments, treatment by incineration and disposal
- Discharge of treated water to stream

Implementation of this RAA fulfills the requirements of cleanup Category III: meet or exceed ARARs for human health. This alternative also is likely to meet the ARARs for the environment.

5.6.1 Compliance with ARARs

The contaminant-specific ARARs described in Section 3.4.3 will be met by combining the various technologies included in this alternative. This RAA also will include compliance with action-specific technologies as described in Section 5.5.1. No location-specific ARARs were identified for this RAA.

5.6.2 Reduction of Toxicity, Mobility or Volume

The evaluation of this RAA with respect to contaminant toxicity, mobility and/or volume is similar to that of RAA No. 4 except that carbon adsorption is used instead of air stripping as the primary groundwater treatment system.

Use of this treatment system in conjunction with groundwater extraction will reduce the volume, toxicity and mobility of contaminants in the groundwater. The exact amount of material to be treated by this system is not known. Estimates based on the concentration isopleth maps in the RI indicate that approximately 4,450 pounds of TCA and approximately 1,750 pounds of DCE still may be present. Over time, these contaminants may be removed from the groundwater system. The treatment system is designed to operate at over 99 percent treatment efficiency so that a large proportion of this contamination will be removed from the extracted groundwater.

Residuals of the treatment process (spent carbon) will not be persistent, toxic, mobile or bioaccumulate in the local environment after disposal. In fact, methods are available (incineration and/or regeneration) to destroy contaminants on the spent carbon.

5.6.3 Short-Term Effectiveness

The environmental monitoring, alternate water supply, groundwater extraction, treatment (liquid-phase carbon adsorption) and discharge, and sediment excavation alternative (RAA No. 5) will reduce the potential public health and environmental risks for both of the completed exposure pathways as defined in the RI. The only difference between this alternative and RAA No. 4, previously discussed in Section 5.5.3, is the use of a liquid-phase carbon adsorption treatment system instead of an air stripping treatment system. As such, the short-term effectiveness evaluation will be essentially the same as Section 5.5.3. Overall, RAA No. 5 is considered to be similarly protective of human health and the environment.

5.6.4 Long-Term Effectiveness

Evaluation of RAA No. 5 with respect to long-term effectiveness is essentially the same as that for RAA No. 4 presented in Section 5.5.4. The major difference between the two alternatives is that the carbon adsorption system will require a more intensive operation and maintenance program. This is because the granular activated carbon in the carbon adsorbers must be frequently changed to maintain an acceptable contaminant adsorption level in the carbon units and to prevent contaminant breakthrough.

In general, the technologies employed by this alternative are effective and reliable.

5.6.5 Implementability

This RAA is essentially the same as RAA No. 4, except that a carbon adsorption treatment system is used instead of an air stripping system. The benefits, reliability, effectiveness, and implementability are analogous to that of RAA No. 4. A detailed evaluation of each of the technologies is given in Sections 5.2 through 5.5 and will not be repeated here; the carbon adsorption treatment system will, however, be discussed.

AR300903

This RAA includes provisions for treatment of contaminated groundwater by carbon adsorption. Carbon adsorption has been used extensively for the treatment of waters containing organic constituents and has been demonstrated to be very effective and reliable. The carbon adsorption technology has developed to the extent that prefabricated treatment systems are available. The use of prefabricated systems is desirable because design and construction costs are minimized and the performance of a particular system under field conditions is well documented.

The carbon adsorption treatment system will use at least two adsorption units. This increases the flexibility, efficiency and operational reliability of the system because: (1) multiple adsorbers decrease the probability of contaminant breakthrough; and (2) one or more units may be taken off line for servicing without disabling the system. Components, such as a pretreatment storage tank, also have been included to keep the system operating efficiently. Overall, the carbon adsorption and air stripping treatment systems are very similar technically and will perform with nearly equal efficiency with respect to contaminant removal from groundwater.

In general, this RAA is analogous to RAA No. 4 and is effective, reliable and implementable.

5.6.6 Community Acceptance

The public perception of this alternative probably will be very similar to that of their perception of RAA No. 4 since both are very similar, except for the treatment unit. The air stripper requires a fan to move air through the stripping column that may create some noise; this would not be expected using a carbon adsorption system.

5.6.7 State Acceptance

This alternative satisfies the state ARARs designed to reduce the toxicity, mobility and volume of the contaminants. Therefore, the state probably will find this alternative acceptable.

5.6.8 Cost

The higher cost of the carbon adsorption units are reflected by the present worth cost of approximately $13,723,878. Results of the cost evaluation are indicated on the following Tables 5-12 and 5-13.

The capital cost for this RAA is approximately $4,936,387 with an annual operation and maintenance cost of approximately $932,171.

5.6.9 Overall Protection of Human Health and the Environment

This alternative is designed to control and reduce the volume of contaminants at the site and, therefore, it meets CERCLA goals. This alternative also satisfies all ARARs for human health and may satisfy the ARARs for the environment. Overall, RAA No. 5 is protective of human health and the environment.

5.7 Remedial Action Alternative No. 6

RAA No. 6 includes remedial measures that provide treatment for the contaminated groundwater and reinjection of the treated water back into the aquifer rather than discharging it to surface water bodies. The primary components of RAA No. 6 are listed below:

- Continued and expanded surface water and groundwater monitoring
- Installation of an alternate water supply system
- Groundwater extraction
- Groundwater treatment by air stripping system with vapor-phase carbon adsorption
- Excavation of contaminated sediments, treatment by incineration and disposal
- Discharge of treated water by injection

Implementation of this RAA fulfills the requirements of cleanup Category IV: meet or exceed ARARs for both human health and the environment.

AR300905

Table 5-12

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 5[1]

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
A. Monitoring	$ 845,831	$154,151	$1,453,165	$ 2,298,996
Alternate Water Supply System:				
B. New Well Field[2]	1,151,272	55,100	519,427	1,670,699
C. Expand Topton System	1,217,000	0[3]	0	1,217,000
D. Expand Mt. Village System	699,000	0[3]	0	699,000
E. Groundwater Extraction System	1,490,373	176,019	1,659,312	3,149,685
F. Water Treatment (Carbon Adsorption)	920,386	508,297	4,791,671	5,712,057
G. Excavation, Treatment and Disposal of Sediments	47,863	0	0	47,863
H. Discharge to Stream	480,662	38,604	363,916	844,578
Total = A + B + E + F + G + H	$4,936,387	$932,171	$8,787,491	$13,723,878

(1) Costs presented in 1988 dollars.
(2) The new well field option of the alternate water supply system was used to develop the total RAA cost.
(3) The O&M cost would be the responsibility of the water commission and not funded through the Superfund program.

AR300906

Table 5-13

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 5[1]
($1,000)

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$10,612.0	$11,787.6	$12,963.2	$14,138.8
Original	12,280.6	13,685.0	15,089.5	16,494.0
High	15,159.8	17,002.9	18,846.1	20,689.2

(1) Costs presented in 1988 dollars.

Anc

AR300907

5.7.1 Compliance with ARARs

The contaminant-specific ARARs described in Section 3.4.3 will be met by implementation of this RAA. This RAA also will include compliance with action-specific ARARs such as OSHA regulations, a site-specific health and safety plan, regulations governing transportation and disposal of drill cuttings, construction debris, contaminated sediments, and treatment sludges, water supply treatment, deep well injection permits, and wetlands and floodplains regulations. No location-specific ARARs were identified for this alternative.

5.7.2 Reduction of Toxicity, Mobility or Volume

Remedial action alternative No. 6 is similar to RAA No. 4 except that treated effluent is discharged by a deep well injection system rather than to a nearby stream. The reduction of toxicity, mobility and/or volume of contaminants is discussed in detail in Section 5.5.2.

5.7.3 Short-Term Effectiveness

The monitoring, alternate water supply, groundwater extraction, treatment (air stripping with vapor-phase carbon adsorption), reinjection, and excavation of sediments alternative (RAA No. 6) will reduce the potential public health and environmental risks for both of the completed exposure pathways as defined in the RI. The only difference between this alternative and RAA No. 4, previously discussed in Section 5.5.3, is the reinjection of the treated groundwater rather than discharge of the treated groundwater to the watershed. As such, the short-term effectiveness of this alternative will be the same as Section 5.5.3, except for potential public health and environmental risks associated with construction and operation of the injection system. Additional minimal acute exposures would result from the drilling of the additional injection wells and construction of the injection system. Both exposures are controllable by appropriate action-specific ARARs. Protection of human health and the environment will be achieved by this alternative upon implementation.

5.7.4 Long-Term Effectiveness

The long-term effectiveness of this alternative is essentially the same as RAA No. 4. The use of an injection system in this alternative will increase the required operation and maintenance of the system. Maintenance may include such items as well redevelopment and pump servicing and replacement.

AR300908

5.7.5 Implementability

This RAA includes six technologies: environmental monitoring, alternate water supply, groundwater extraction, treatment by air stripping with vapor-phase carbon adsorption, excavation of sediments and treatment by incineration, and injection of treated water. The first five technologies are discussed in detail in Sections 5.3 through 5.5.

Injection of fluids into aquifers has been used for many purposes including liquid storage and disposal, as well as aiding the extraction of contaminants or other substances (i.e., oil). This technology has been demonstrated to be effective, reliable, and flexible.

Ten injection wells have been included in this RAA. This increases the flexibility of the injection/extraction system because the system may be adjusted to control both the disposal rates and the flow field in the aquifer. Although the injection system was designed primarily for the disposal of treated water, the secondary effects, such as improved contaminant extraction efficiency, may prove to be quite beneficial. Having multiple injection wells on two separate main-lines also increases the protection against system failure.

Implementation of an injection well system is well documented and, in general, uses standard equipment and procedures. It may be necessary, however, to consider induced fracturing of the rock either by hydraulic pressure or by blasting. If this action, based on further field study, is deemed necessary to increase the efficiency of the injection wells, then specialized studies or personnel may be necessary.

Overall, this RAA includes technologies that are all reliable and relatively easy to implement and construct. The injection well system may require some specialized services. Efficient implementation of all technologies included in this alternative will require strong management organization and planning, as well as good communication between government agencies/offices, the contractors and the public. All technologies associated with this RAA, and the RAA as a whole, are effective, reliable, and implementable.

5.7.6 Community Acceptance

This alternative probably would be favorably received by the residents due to the degree of risk minimization it provides to the public health and the environment. Also, the potential

AR300909

downgradient receptors probably would have a positive perception of this alternative since the existing stream flows would be less adversely affected.

5.7.7 State Acceptance

This alternative satisfies most of the ARARs designed to reduce the toxicity, mobility, and volume of the contaminants. Therefore, the state probably will find this alternative acceptable.

5.7.8 Cost

The present worth cost of installing and maintaining this alternative for a 30-year period is about $14,218,604. Other information on the results of the cost evaluation are listed in Tables 5-14 and 5-15.

The capital cost for this alternative is approximately $6,073,331 and the annual operation and maintenance cost is expected to be about $864,045.

5.7.9 Overall Protection of Public Health and the Environment

This alternative fulfills all ARARs for human health and the environment. This RAA also inhibits contaminant migration and reduces contaminant volume; it meets CERCLA goals. Overall, this alternative is protective of both human health and the environment.

5.8 Remedial Action Alternative No. 7

This RAA is essentially the same as RAA No. 6 except that a carbon adsorption treatment system is used instead of an air stripping system. The components of this alternative are listed below:

- Continued and expanded surface water and groundwater monitoring
- Installation of an alternate water supply system
- Groundwater extraction
- Groundwater treatment by carbon adsorption
- Excavation of contaminated sediments, treatment by incineration and disposal
- Discharge of treated water by injection

AR300910

Table 5-14

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 6(1)

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
A. Monitoring	$ 845,831	$154,151	$1,453,165	$ 2,298,996
Alternate Water Supply System:				
B. New Well Field(2)	1,151,272	55,100	519,427	1,670,699
C. Expand Topton System	1,217,000	0	0	1,217,000
D. Expand Mt. Village System	669,000	0	0	699,000
E. Groundwater Extraction System	1,490,373	176,019	1,659,312	3,149,685
F. Air Stripping Treatment System:(2)	902,336	104,390	984,079	1,886,415
G. Air Stripping with Vapor-Phase Carbon Adsorption	1,161,984	424,934	4,005,815	5,167,799
H. Air Stripping with Liquid- and Vapor-Phase Carbon Adsorption	1,761,884	519,394	4,896,315	6,658,199
I. Excavation, Treatment and Disposal of Sediments	47,863	0	0	47,863
J. Discharge Injection	1,376,008	53,841	507,554	1,883,562
Total = A + B + E + G + I + J	$6,073,331	$864,045	$8,145,273	$14,218,604

(1) Costs presented in 1988 dollars.
(2) The new well field option of the alternate water supply system and the air stripping with vapor-phase carbon adsorption option of the water treatment system were used to develop the total RAA cost.

AR300911

Table 5-15

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 6[1]
($1,000)

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$10,756.3	$12,066.4	$13,376.5	$14,686.7
Original	12,606.9	14,182.5	15,758.0	17,333.6
High	15,958.4	18,051.2	20,144.0	22,236.8

(1) Costs presented in 1988 dollars.

AR300912

Implementation of this RAA fulfills the requirements of cleanup Category IV: meet or exceed ARARs for both human health and the environment.

5.8.1 Compliance with ARARs

The contaminant specific ARARs described in Section 3.4.3 will be met by implementation of this RAA. This RAA also will include compliance with action-specific ARARs such as OSHA regulations, a site-specific health and safety plan, regulations governing transportation and disposal of drill cuttings, construction debris, contaminated sediments, and treatment sludges, water supply treatment, deep well injection permits, and wetlands and floodplains regulations. No location-specific ARARs were identified for this alternative.

5.8.2 Reduction of Toxicity, Mobility or Volume

RAA No. 7 is similar to RAA No. 5 except that treated effluent is discharged by a deep well injection system rather than to a nearby stream. The reduction of toxicity, mobility or volume of contaminants is discussed in detail in Section 5.6.2

5.8.3 Short-Term Effectiveness

The monitoring, alternate water supply, groundwater extraction, treatment (liquid-phase carbon adsorption) and reinjection, and excavation of sediments alternative (RAA No. 7) would reduce the potential public health and environmental risk for both of the completed exposure pathways as defined in the RI. The only difference between this alternative and RAA No 6 is the use of the liquid-phase carbon adsorption system instead of the air stripping system. As such, the short-term effectiveness of this alternative will be the same as Section 5.6.3. This alternative removes the additional exposure pathway that was not defined in the RI (contact with treated water discharged to the watershed) and that was discussed in Section 5.5.2. Overall, RAA No. 7 will provide full protection to both human health and the environment.

5.8.4 Long-Term Effectiveness

The long-term effectiveness of this alternative is essentially the same as RAA No. 5. The use of an injection well system in this alternative will increase the required operation and maintenance of the system; annual operation and maintenance will be more extensive for the injection wells than for discharge to a stream. Operation and maintenance may include such items as monitoring of well performance, periodic well redevelopment, and periodic pump maintenance and replacement.

5.8.5 Implementability

This RAA includes six technologies: environmental monitoring, alternate water supply, groundwater extraction, treatment by liquid-phase carbon adsorption, excavation, and disposal/treatment of sediment and injection of treated water.

A detailed evaluation of each of the technologies is given in Sections 5.2 through 5.7 and will not be repeated here. Overall this alternative is implementable, effective, and reliable.

5.8.6 Community Acceptance

The public perception of this alternative should be favorable since it provides for the remediation of the contaminants encountered on site.

5.8.7 State Acceptance

The state ARARs are satisfied since the alternate provides for the reduction of volume, mobility and toxicity of the contaminants. Therefore, the state probably will find this alternative acceptable.

5.8.8 Cost

The present worth cost of RAA No. 7 is approximately $14,762,862 which reflects the increased cost of the carbon adsorption treatment units. Other cost information is listed on Tables 5-16 and 5-17.

The capital cost for this alternative is approximately $5,831,733 and the annual operation and maintenance cost is expected to be approximately $947,408.

AR300914

Table 5-16

BERKS SAND PIT SITE
COST SUMMARY FOR RAA NO. 7[1]

Component	Capital Cost	Annualized O&M Cost	Present Worth O&M Cost	Total Present Worth Cost
A. Monitoring	$ 845,831	$154,151	$1,453,165	$ 2,298,996
Alternate Water Supply System:				
B. New Well Field[2]	1,151,272	55,100	519,427	1,670,699
C. Expand Topton System	1,217,000	0	0	1,217,000
D. Expand Mt. Village System	699,000	0	0	699,000
E. Groundwater Extraction System	1,490,373	176,019	1,659,312	3,149,685
F. Water Treatment (Carbon Adsorption)	920,386	508,297	4,791,671	4,712,057
G. Excavation, Treatment and Disposal of Sediments	47,863	0	0	47,863
H. Discharge by Injection	1,376,008	53,841	507,554	1,883,562
Total = A+B+E+F+G+H	$5,831,733	$947,408	$8,931,129	$14,762,862

(1) Costs presented in 1988 dollars.
(2) The new well field option of the alternate water supply system was used to develop the total RAA cost.

AR300915

Table 5-17

BERKS SAND PIT SITE
SUMMARY OF SENSITIVITY ANALYSIS FOR RAA NO. 7[1]
($1,000)

Cost Factors	Sensitivity Factors			
	0.5	1.0	1.5	2.0
Low	$11,377.0	$12,600.2	$13,823.5	$15,046.8
Original	13,248.0	14,723.8	16,199.5	17,675.3
High	16,558.2	18,529.4	20,500.6	22,471.8

(1) Costs presented in 1988 dollars.

AR300916

5.6.9 Overall Protection of Human Health and the Environment

Implementation of this alternative will fulfill all ARARs for human health and the environment. This RAA also inhibits contaminant migration and reduces contaminant volume and, therefore, meets CERCLA goals. Overall, this RAA is protective of human health and the environment.

AR300917

SUMMARY OF ALTERNATIVES

6.0 SUMMARY OF REMEDIAL ACTION ALTERNATIVES

This section provides an overview of the remedial action alternatives (RAAs) evaluated in Section 5.0 for the Berks Sand Pit Site.

RAAs address a range of cleanup goals that were developed from technologies identified in U. S. EPA guidance documents. The cleanup goals ranged from no action to compliance with applicable or relevant and appropriate requirements (ARARs). The alternatives included technologies providing management of contaminant migration, treatment of contaminated water, and excavation and treatment/disposal of contaminated sediments.

The RAAs evaluated for the remediation of contaminated groundwater, surface water and sediments included

<u>RAA No. 1</u> Continued monitoring of existing wells (groundwater) and surface water.

<u>RAA No. 2</u> Surface water and groundwater monitoring, including the installation of additional monitoring wells.

<u>RAA No. 3</u> Surface water and groundwater monitoring, including the installation of additional monitoring wells and installation of an alternate water supply system.

<u>RAA No. 4</u> Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by air stripping with vapor-phase carbon adsorption and optional liquid-phase carbon adsorption, discharge of treated water to the watershed (stream), and excavation, treatment by incineration and disposal of contaminated sediments.

<u>RAA No. 5</u> Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by carbon adsorption, discharge of treated water to the watershed (stream), and

AR300919

excavation treatment by incineration and disposal of contaminated sediments.

RAA No 6 Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by air stripping with vapor-phase carbon adsorption and optional liquid-phase carbon adsorption, discharge of treated water by reinjection into aquifer, and excavation treatment by incineration and disposal of contaminated sediments.

RAA No 7 Surface water and groundwater monitoring, including the installation of additional monitoring wells, installation of an alternate water supply system, groundwater extraction, groundwater treatment by carbon adsorption, discharge of treated water by reinjection, and excavation treatment by incineration and disposal of contaminated sediments

Tables 6-1 through 6-4 provide a summary of the evaluation performed in Section 5.0 for the RAAs developed for the Berks Sand Pit Site. Details for the cost analysis are included in Appendices A and B.

AR300920

Table 6-1

BERKS SAND PIT
SUMMARY OF REMEDIAL ACTION ALTERNATIVES ABILITY TO COMPLY WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO REDUCE CONTAMINANT TOXICITY, MOBILITY OR VOLUME

Criteria	RAA No. 1			RAA No. 2			RAA No. 3			RAA No. 4			RAA No. 5			RAA No. 6			RAA No. 7		
	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U
Comply with ARARs																					
Contaminant-Specific		X			X			X		X			X			X			X		
Action-Specific	X			X			X			X			X			X			X		
Location-Specific[1]																					
Reduce																					
Toxicity		X			X			X		X			X			X			X		
Mobility		X			X			X		X			X			X			X		
Volume		X			X			X		X			X			X			X		

Y = Yes N = No U = Uncertain

[1]No location-specific ARARs were identified.

AR300921

Table 6-2

BERKS SAND PIT

…F REMEDIAL ACTION ALTERNATIVES SHORT- AND LONG-TERM EFFECTIVENESS AND IMPLEMENTATION

Criteria	RAA No. 1			RAA No. 2			RAA No. 3			RAA No. 4			RAA No. 5			RAA No. 6			RAA No 7		
	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U
Short-Term Effectiveness:																					
Reduce Risks		X			X			X		X			X			X			X		
Pose Risk to Community	X							X			X			X			X			X	
Pose Risk to Workers	X			X			X			X			X			X			X		
Pose Risk to Environment	X			X								X			X		X			X	
Health Protection Achieved		X			X			X			X			X		X				X	
L… …ectiveness:																					
…ing	X			X			X				X			X			X			X	
	X			X			X			X			X			X			X		
	X			X			X			X			X			X			X		
		X				X	X			X			X			X			X		
	X			X			X			X			X			X			X		
				X			X			X			X			X			X		
				X			X			X			X			X			X		
					X		X			X			X			X			X		

Y = Yes N = No U = Uncertain

Table 6-3

BERKS SAND PIT
SUMMARY OF REMEDIAL ACTION ALTERNATIVES COMMUNITY AND STATE ACCEPTANCE AND OVERALL LEVEL OF PROTECTION

Criteria	RAA No. 1			RAA No. 2			RAA No. 3			RAA No. 4			RAA No. 5			RAA No. 6			RAA No. 7		
	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U
Acceptable to Community		X			X		X			X			X			X			X		
Acceptable to State		X			X			X		X			X			X			X		
Protective of:																					
Human Health		X			X		X			X			X			X			X		
Environment		X			X			X		X			X			X			X		
Meets CERCLA Goals: overall protection		X			X			X		X			X			X			X		

Y = Yes N = No U = Uncertain

AR300923

Table 6-4

BERKS SAND PIT
SUMMARY OF COST ANALYSIS FOR EACH OF THE REMEDIAL ACTION ALTERNATIVES[1]
($1,000)

Cost	RAA No 1	RAA No 2	RAA No 3	RAA No 4	RAA No 5	RAA No 6	RAA No 7
Capital Cost	0	845 8	1,887 1	5,178 0	4,936 4	6,073 3	5,831 7
Annual O&M Cost	95.7	154.2	209.3	848 8	932 2	864 0	947 4
Present Worth O&M Cost	902.6	1,453 2	1,972 6	8,001 6	8,787.5	8,145 3	8,931 1
Total Present Worth Cost	**902.6**	**2,299.0**	**3,969.7**	**13,179.6**	**13,723.9**	**14,218.6**	**14,762.9**
Lowest Cost from Sensitivity Analysis	669 0	1,539 6	2,712.0	9,991 3	10,612.0	10,756 3	11,377.0
Highest Cost from Sensitivity Analysis	1,352.2	4,151 3	7,003.3	20,454.2	20,689.2	22,236.8	22,471 8
Percent Change in Costs from Sensitivity Analysis	8 3 to + 8 3	14 3 to 25 6	16 0 to 30.3	-14.7 to 26.6	-14.3 to 25 4	15 3 to 28.3	14.9 to 27 1

Costs presented in 1988 dollars

AR300924

ORIGINAL
(Red)

APPENDIX A

Classified

APPENDIX A

DESIGN CALCULATIONS AND COST ESTIMATES

AR300926

NO ACTION

Baker Engineers

S.O. No. 15438-17-SR1

Subject: Berks Sand Pit
No Action Alternative

Sheet No. 1 of 2

Drawing No.

Computed by RPA Checked By PSW Date 9/7/88

Revision #2

• This Alternative includes monitoring of existing wells and surface water sampling points: ✓

13 Surface Water Point
18 Residential Wells
9 MW Wells
7 SW Wells
3 ERT Wells
50
×20% for Blanks etc
60 samples annually

• Analytical Cost

Package cost of $150/sample if analysed for eight PA regulated VOCs [1]

- Trichloroethylene
- Carbon Tetrachloride
- 1,1,1-Trichloroethane
- Benzene
- 1,2-Dichloroethane
- Vinyl Chloride
- p-Dichlorobenzene
- 1,1-Dichloroethene

60 samples/year × $150/sample = $9000.00/year

• Operating Labor for Sampling:

Use a 4 man sampling crew (2 geologists; 2 technician
Assume 4 Hours per sample (including purging and decon)

Geologist: 2[60 × 4] = 480 Hours

Technician: 2[60 × 4] = 480 Hours

1. NUS Corporation 1988 Price Catalogue

Baker Engineers

S.O. No. 15438-17-SR1

Subject: Berks Sand Pit

No Action Alternative

Sheet No. 2 of 2

Drawing No.

Computed by RPA Checked By PSW Date 9/7/88

REVISION #2

Labor	Hours	Rate	Total
Geologist (field)	480	70.00 *	33600
Technician (field)	480	60.00 *	28,800
Geologist (office)	80	55.00	4,400.
Clerical	8	25.00	200.
Management	8	75.00	600.
Computer Time	80	$10.00	$800.
			68400

* includes per diem expenses

AR300929

ORIGINAL (Red)

SYSTEM, NO ACTION ALTERNATIVE DFNOACTI.WK1

[illegible] ANNUAL OPERATION COSTS

NO.	ITEM DESCRIPTION	ANNUAL QUANTITY	UNITS	UNIT COST	ANNUAL COST
1)	OPERATING LABOR				
	(A) PROFESSIONALS (2) FOR SAMPLING	480	HR	$70.00	$33,600
	(B) TECHNICIANS (2) FOR SAMPLING	480	HR	$60.00	$28,800
	(C)				
2)	ANALYTICAL TESTING				
	(A) ~~QUARTERLY~~ ANNUAL	60	TESTS	$150.00	$9,000
	(B)				
3)	WELL MAINTENANCE				
	(A) REDEVELOPMENT EACH 5-YEARS [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4.	DATA VALIDATION				
5	PURCHASED SERVICES				
	(A)				
6,	DISPOSAL				
	(A)				
7,	REVIEW MONITORING DATA				
	PROFESSIONAL	80	HR	$55.00	$4,400
	MANAGEMENT	8	HR	$75.00	$600
	CLERICAL	8	HR	$25.00	$200

AR300930

DRAFTING		16 HR	$40.00	[illegible]
COMPUTER		20 HR	$10.00	[illegible]
8 INSURANCE, TAXES, LICENSES				
(A)				
(B)				
(C)				
9) OTHER COSTS				
(A)				
A) SUBTOTAL (A)				$79,790
B) CONTINGENCY COST AT [illegible]% OF SUBTOTAL (A)				[illegible]
C) SALVAGE AND DECOMMISSION: AT [illegible]% CAPITAL COSTS INCURRED AT 30-TH YEAR, INTEREST = 10% ANNUAL SINKING PAYMENT				
D) ANNUALIZED CAPITAL COST				[illegible]
E) PRESENT WORTH AT 10% INTEREST AT 30 YEARS				[illegible]

ORIGINAL (Red)

ORIGINAL
(Red)

MONITORING SYSTEM

Baker Engineers

S.O. No. 15438-17-SR1

Subject: Berks Sand Pit

Monitoring Wells

Sheet No. 1 of 8 ORIGINAL (Red)

Drawing No.

Computed by RPA Checked By TJW Date 9/8/88

Revision # 1

Monitoring Wells

- In order to monitor the full depth of contamination well clusters should be used
- Although the maximum depth of contamination has not been determined, assume, for design purposes a maximum depth of 300 feet. This depth should be verified prior to or during well installation
- Use 3 wells per cluster:

Total Depth (ft)	Screened Interval (ft)	Screen Length (ft)
80	30 - 80	50
150	80 - 150	70
300	150 - 300	150

The 80-foot well will be used to monitor a shallow aquifer

The two deep wells (150 and 300 feet) will be used to monitor the fractured bedrock aquifer

Baker Engineers

S.O. No. 15438-17-SR1

Subject: Berks Sand Pit

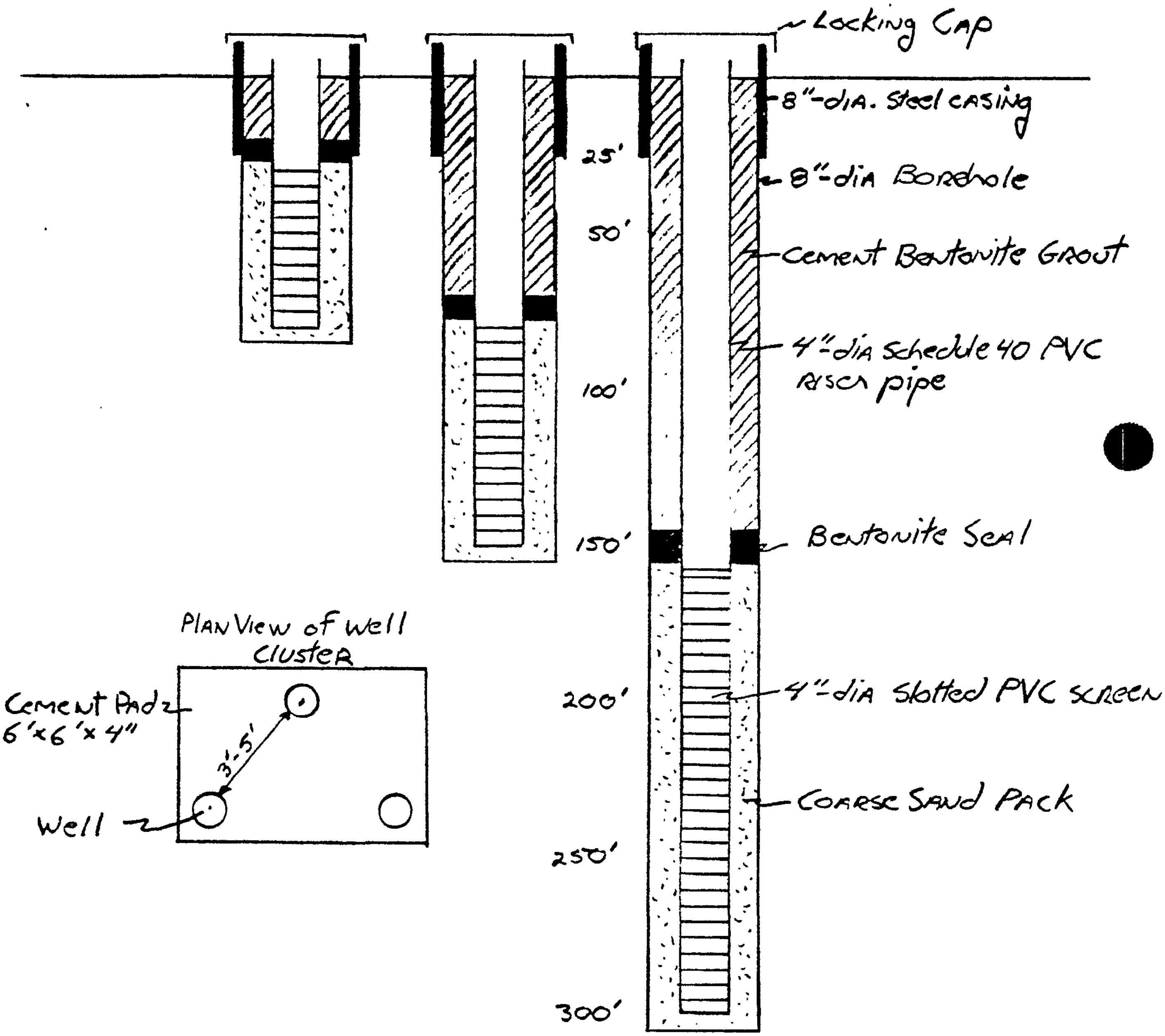
Monitoring Wells

Sheet No. 2 of 8

Drawing No.

Computed by RPA Checked By TSW Date 9/8/88

REVISION #1



AR300934

Baker Engineers

S.O. No. 15438-17-SR1

Subject: Berks Sand Pit
Monitoring System

Sheet No. 3 of 8

Drawing No.

Computed by RPA Checked By PSW Date 9/8/88

Revision #1

- Use 7 3 well clusters (21 wells total)
- Core 3 wells with NX equipment (2.98"-dia borehole) to 300 ft
  ream holes to 8"-dia.

1. Drilling, 8"-dia borehole

   7 clusters × (80 + 150 + 300 ft/cluster) = 3710 LF

   use → 3800 LF

2. Coring: NX

   Assume top of rock is 25 feet
   so core 275 feet in 3 wells

   7 wells × 275 ft/well = 1925 LF

3. No. of Core Boxes: assuming 12 LF/Box

   $\frac{1925\ LF}{12\ LF/Box} = 160.4$ Boxes

   use → 165 Boxes

4. 8" dia Steel Casing: assuming 30 feet of casing per well

   21 wells × 30 ft/well = 630 LF

5. 4" dia Schedule 40 Flush Jointed and Threaded Solid PVC casing

   80' well : 40 LF
   150' well : 90 LF
   300' well : 160 LF
   Total 290 LF/cluster

   7 clusters × 290 LF/cluster = 2030 LF

AR300935

Baker Engineers

S.O. No. 15438-17-SRI

Subject: BERKS SAND PIT
Monitoring System

Sheet No. 4 of 8

Drawing No.

Computed by RPA Checked By PJW Date 9/8/88

REVISION #1

6. 4"-dia PVC SCREEN:

80' well: 50 LF
150' well: 70 LF
300' well: 150 LF

Total 270 LF/cluster

7 clusters × 270 LF/cluster = 1890 LF

USE 1900 LF

7. Fittings

4" dia endcaps and extenders : 21
Locking Caps w/ Locks : 21

8. Concrete Pads

$7 \text{ clusters} \times (6' \times 6' \times 4''/12'')/27 \text{ CF/CY} = 3.1 \text{ CY}$

USE 5 CY

9. Grout (Portland Cement w/ 4% Bentonite)

80' well: 28 LF
150' well: 78 LF
300' well: 148 LF

Total : 254 LF USE 255 LF/cluster

7 clusters × 255 LF/cluster = 1785 LF

USE 1800 LF

Area per hole:

$$\frac{\pi}{4}\left(\left(\frac{8''}{12}\right)^2-\left(\frac{4''}{12}\right)^2\right) = 0.26 \text{ ft}^2$$

Volume: $(0.26 \text{ ft}^2 \times 1800 \text{ LF}) = 468 \text{ CF}$

USE: 470 CF

AR300936

Baker Engineers

S.O. No. 15438-17-SR ORIGINAL (Red)

Subject: BERKS SAND PIT MONITORING System

Sheet No. 5 of 8

Drawing No.

Computed by RPA Checked By RSW Date 9/8/88

REVISION #1

10. Portland Cement (96% of Grout)

$$\frac{(470\ CF \times 196\ lb/CF)}{96\ lb/BAG} \times .96 = 921\ Bags$$

USE 925 Bags

11. Bentonite (4% of Grout) (Powdered)

$$\frac{(470\ CF \times 80\ lb/CF)}{50\ lb/BAG} \times .04 = 30.1\ Bags$$

USE 30 Bags.

12. Bentonite Pellets (3' seal in each well)

$$3\ LF/well \times 0.26\ ft^2 \times 21\ wells = 16.4\ CF$$

$$\frac{16.4\ CF \times 80\ lb/CF}{50\ lb/BAG} = 26.2\ Bags$$

USE → 30 BAGS

13. Coarse Sand:

80' well: 50 LF
150' well: 70 LF
300' well: 150 LF

Total 270 LF

$$\frac{270\ LF/cluster \times 7\ clusters \times 0.26\ ft^2}{27\ CF/CY} = 18.2\ CY$$

USE 20 CY

14. Volume of Cuttings

$$7\ clusters \times (300+150+80\ ft/cluster) = 3800\ LF$$

$$AREA: \frac{\pi}{4}\left(\frac{8}{12}\right)^2 = 0.35\ ft^2$$

$$Volume = (3800\ LF) \times (0.35\ ft^2) = 1330\ CF$$

USE 1350

AR300937

S.O. No. 15438-17-SRI ORIGINAL (Red)

Baker Engineers

Subject: BERKS SAND PIT MONITORING SYSTEM

Sheet No. 6 of 8

Drawing No.

Computed by RPA Checked By RSW Date 9/8/88

REVISION #1

15 Equipment: 2 Drill Rigs
1 Steam Cleaner
1 Bulldozer - trk mtd medium
1 Water Truck
1 Flat Bed Truck

16. Professional Field Staff

	Rate	Rate*
1 Geologist (coordinator)	55.00	70.00
1 Health and Safety Officer	55.00	70.00
1 Geologist	45.00	60.00

* Rate includes $80/day perdiem per 8 hour day

Assume a 4-month construction Period

Geologist (Coordinator)
4 mnths × 4.2 wks/mn × 5 d/wk × 8 hrs/day = 672 hours
say 700 hours

Health and Safety Officer
3 wks × 5 d/wk × 8 hrs/day = 120 hrs

Geologist
3 mnths × 4.2 wks/mnth × 5 d/wk × 8 hrs/d = 504 hours
say → 510 hours

	Rate	Hours	Total $
Geologist (Coord.)	70.00	700	49,000.
H&S	70.00	120	8,400.
Geologist	60.00	510	30,600.–

AR300938

Baker Engineers

S.O. No. 15438-17-SRI ORIGINAL (Red)

Subject: BERKS SAND PIT MONITORING System

Sheet No. 7 of 8

Drawing No.

Computed by RPA Checked By DS Date 9/8/88

REVISION #1

17. Well Construction Labor

Assume 2-day/well cluster to construct

Driller \$250/day

Helper \$200/day

\$450/day

7 clusters × 2 days/cluster = 14 days

18. Packer Tests

Perform in 1 hole/cluster (300 ft hole) for 7 clusters

Assume 10 tests per hole

Assume 1 day per hole at \$200/hr (Labor, mat., equip) vendor quote

(7 holes × 8 hrs/hole × 200/hr) = \$11200

Analytics: \$150/sample × 5 samples/hole × 7 holes = \$5250.

19 Well Development

\$175/hour (Labor, mat, equip) vendor Quote

Assume 3 hrs/well

3 Hrs/well × 21 wells = 63 hours

63 hours × \$175/hour = \$11,025

20. Borehole Geophysics

Assume a total of \$7500.00

AR300939

Baker Engineers

S.O. No. 15438-17-~~3~~1

Subject: Berks Sand Pit Monitoring System

Sheet No. 8 of 8

Drawing No.

Computed by RPA Checked By RSW Date 9/9/88

REVISION #1

21 Pump Tests

Use 2-72 hour tests + 28 hrs recovery/test
\$200/hr

2 × (72+28) = 200 hours + 30 hours set-up

230 hrs × \$200/hr = \$46,000

~~22 Disposal of Cuttings~~

Delete

~~a) Use 55 gal DOT Drums @ 1/4 CY/DRUM~~

~~Assume 1/4 of cuttings will need to be containerized, transported off site and incinerated (determined by field screening)~~

~~1350 CF × 0.25 = 337.5 CF = 12.5 CY~~
~~Use 15 CY~~

~~Number of Drums:~~

~~$\frac{15\ CY}{0.25\ CY/DRUM}$ = 60 Drums at \$25/drum~~

~~b.) Transport Drums~~
~~\$4.00 Load mile for 150 miles and 1 Loads~~

~~1 Loads × \$4.00 Load mile × 150 miles = \$600~~

~~c) Analytics: Composite Samples: 10 samples~~

~~10 samples × \$850/sample = \$8500~~

~~D) Incineration @ \$650 per drum~~

~~60 drums × \$650/drum = \$39,000~~

~~E) Drum Handling: Assume 1 Hr/Drum at \$200/hr (Geologist + Technician)~~

~~60 drums × 1 Hr × \$200/hr = \$12,000~~

R3A0910

Baker Engineers

S.O. No. 15438-17-SRI

Subject: Berks Sand Pit Monitoring System O&M Costs

Sheet No. 1 of 2

Drawing No.

Computed by RPA Checked By RSW Date 9/8/88

Revision #1

1. Labor (Field-Sampling)

Annual Sampling of:

50 existing sampling points
5 new surface water sampling points
21 new monitoring wells

76 samples
×20% for Blanks

91.2 samples ⟶ USE 95 samples/year

USE 4-MAN sampling crew (2 geologists, 2 technicians) At 4-Hours per sample

95 samples × 4 Hours/sample = 380 hours

Geologists	2	$70/hour	380hrs	53200
Technicians	2	60/hour	380hrs	45600

2. Analytical Costs

$150/sample × 95 samples = $14,250.

3. Well Redevelopment: Once every 5 years at 40 wells

$$\frac{3\ \text{Hrs/well} \times \$175/\text{hr} \times 40\ \text{wells}}{5\ \text{years}} = \$4200/\text{year}$$

AR300941

Baker Engineers

S.O. No. 19438-17-SRL

Subject: Berks Sand Pit Monitoring System O&M

Sheet No. 2 of 2

Drawing No.

Computed by RPA Checked By RSW Date 9/8/88

REVISION #1

4. Engineering

Geologist	80 hrs @ $55/hr	=	4400
Management	16 hrs @ $75/hr	=	1200
Clerical	8 hrs @ $25/hr	=	200
Computer	60 hrs @ $10/hr	=	600

AR300942

Baker Engineers

S.O. No. 15438-17-SRI (Red)

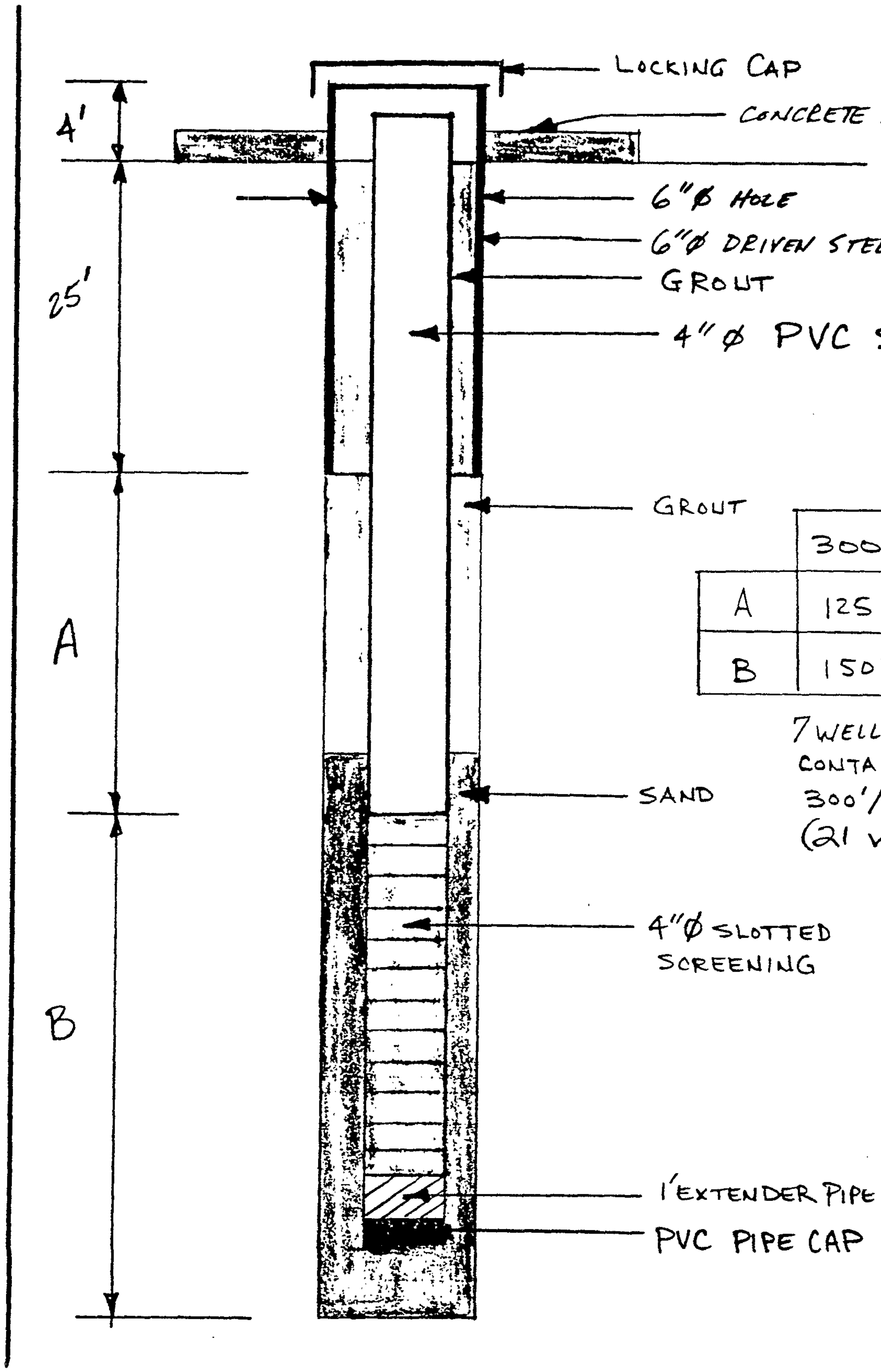
Subject: BERKS SAND PIT MONITORING WELLS CONCEPTUAL DESIGN

Sheet No. 1 of 6

Drawing No.

Computed by LJS Checked By RPA Date 6/8/88

Revised 9/8/88
Delete



	WELL DEPTHS		
	300'	150'	80'
A	125'	55'	5'
B	150'	70'	50'

7 WELL CLUSTERS; EACH CONTAINING A 300'/150'/80' WELL (21 WELLS TOTAL)

PLUS:
2,100 VLF OF 2"Ø NX CORING ON THE 300' WELLS WITH SAMPLING.

AR300943

Baker Engineers

S.O. No. 15438-17-S ORIGINAL (Red)

Subject: BERKS SAND PIT
MONITORING WELLS — Sheet No. 2 of 6
CONCEPTUAL DESIGN — Drawing No.

Computed by LJS — Checked By RPA — Date 6/8/88

REVISED 9/8/88
Delete

(1) DRILLING, ~~6"φ~~ 8" HOLE

7 CLUSTERS × (80' + 150' + 300') ≡ 3,800 VLF

(2) CORING, 2"φ NX WITH SAMPLING

(7 WELLS × ~~300~~ 275 '/WELL) = ~~2,100~~ 1925 VLF

(3) # OF CORING BOXES

~~2,100~~ 1925 LF ÷ 12 LF/BOX ≡ ~~175~~ 165 BOXES

(4) PIPE, 6"φ STEEL CASING

(21 WELLS × 25') + (21 WELLS × 4' STICKUP) ≡ 620 LF

(5) PIPE, 4"φ SOLID PVC CASING

[7 CLUSTERS × (125 + 55 + 5)] + 620 ≡ 2,000 LF

(6) SCREENING, 4"φ PVC FACTORY SLOTTED FLUSH THREAD

7 × (150 + 70 + 50) ≡ 2,000 LF

(7) FITTINGS

4"φ COUPLINGS 42
4"φ CAPS/EXTENDERS 21
LOCKING CAPS 21

AR300944

Baker Engineers

S.O. No. 15438-17-SRI

Subject: BERKS SAND PIT
MONITORING WELLS
CONCEPTUAL DESIGN

Sheet No. 3 of 6

Drawing No.

Computed by LJS Checked By RPA Date 6/8/88

REVISED 9/8/88
Delete

(8) CONCRETE PADS

7 CLUSTERS x (6'x6'x 4"/12)/27 ≡ 5 CYD

(9) GROUT (PORTLAND CEMENT WITH 4% BENTONITE)

7 CLUSTERS X (150 + 80 + 30) = LENGTH ≡ 2,000 LF

$0.785398\left(\frac{6''}{12}^2 - \frac{4''}{12}^2\right) = \frac{\text{AREA}}{\text{HOLE}} = 0.109$ SF

VOLUME = (0.109 x 2,000) ≡ 220 CF

(10) PORTLAND CEMENT (96% OF GROUT)

(220 CF X 0.96 X 196 PCF) ÷ 96 P/BAG ≡ 450 BAGS

(11) BENTONITE PELLETS (4% OF GROUT)

(220 CF X 0.04 x 80 PCF) ÷ 50 P/bag ≡ 15 bAGS

(12) SAND PACKING

7 x (150 + 70 + 50) ≡ 2,000 CFT (75 CYD)

(13) VOLUME OF BORE HOLE CUTTINGS, ETC

7 CLUSTERS X (300 + 150 + 80) ≡ LENGTH ≡ 4,000 LF...

$\frac{\pi(6/12^2)}{4}$ = AREA ≡ 0.20 SF

4000 x 0.20 = 800 CFT

VOLUME ≡ (800 CFT + SAY 100 CF) ≡ 900 CFT

Baker Engineers

S.O. No. 15438-17-SRI

Subject: BERKS SAND PIT
MONITORING WELLS
CONCEPTUAL DESIGN

Sheet No. 4 of 6

Drawing No.

Computed by LJS Checked By RPA Date 6/8/88

REVISION DATE: 6/29/88

Revised 9/9/88

~~Delete (14)~~

(14) DISPOSAL OF CUTTINGS, ETC.

(a) 55 GAL DOT DRUMS @ 7 CFT/DRUM

(900 CFT/7) ≡ 130 DRUMS @ $25 EACH FOB SITE
($3,250)

(b) INCINERATE DRUMS DUE TO LAND BAN ON "F" SERIES WASTES ($800/DRUM + TESTING).

(c) $2,000 FOR DRUM STORAGE AREA

(d) 250 MILE HAUL ONE-WAY TO INCINERATOR
$3.50/LOAD-MILE TRANSPORT COST
60 DRUMS PER LOAD
(130/60) = 3 LOADS
(3 x 250) = 750 LOAD-MILES ($2,625)

(e) DRUM HANDLING, LOADING, FILLING, ETC.
ASSUME 1-HR/DRUM
(130 x 1) = 130 MAN-HOURS
(130/8) ≡ 17 MAN-DAYS
MEANS (1988) SITE: CREW B-10N
($550/DAY x 17) = $9,350

(f) ANALYTICAL TESTING
PASS/FAIL (2/HOLE * 21 HOLES * $500/SAMPLE) = $21,000
DRUMS TO INCINERATOR
(3 SAMPLES x $1,500@) ≡ $4,500

AR300946

Baker Engineers

S.O. No. 15438-17-SPI

Subject: BERKS SAND PIT
MONITORING WELLS
CONCEPTUAL DESIGN

Sheet No. 5 of 6

Drawing No.

Computed by LJS Checked By RPA Date 6/8/88

REVISED 9/8/88
Delete

(15) EQUIPMENT REQUIRED

2 DRILLING RIGS
1 STEAM CLEANER SET-UP
1 CEMENT MIXER 2CYD
1 WATER TRUCK
1 BULLDOZER - TRK MTD, MEDIUM
1 FLATBED TRUCK
1 WELDING MACHINE

(16) PROFESSIONAL FIELD STAFF

{1 GEOLOGIST, 1 H&S OFFICER} @ \$45/HR. (\$80/HR WITH SUBSISTANCE, ETC)

ASSUME 4-MONTH CONSTRUCTION PERIOD

$\left(4 \times 4.2 \frac{WKS}{MON.} \times 5 \frac{DAYS}{WK} \times 8 \frac{HRS}{DAY}\right) \equiv 700$ HOURS

$(700 HR \times 2 \times 80/HR) = \$112,000$ "LABOR"

(17) PACKER TESTS

1 HOLE/CLUSTER (300' HOLE)

1 DAY/HOLE \$200/HR (LABOR, MAT'L, EQUIP)
VENDER QUOTE

$(7 \times 8 HR \times \$200) = \$11,200$

ANALYTICS

$(\$150/SAMPLE \times 7 WELLS \times 5 SAMPLES/WELL) = \$5,250$

AR300947

Baker Engineers

S.O. No. 15438-17-SRI

Subject: BERKS SAND PIT
MONITORING WELLS
CONCEPTUAL DESIGN

Sheet No. 6 of 6

Drawing No.

Computed by LJS Checked By RPH Date 6/8/88

REVISION DATE: 6/29/88
Revised 9/8/88
Delete

(18) WELL DEVELOPMENT

$175/HOUR (LABOR, MAT'L, EQUIP) VENDER QUOTE

USE 5 HR/WELL TO DEVELOP & SET-UP

$\big(\underbrace{5 \times 21}_{105\ \text{HOURS}} \times 175\big) = \$18{,}375$

(19) WELL CONSTRUCTION

ASSUME: 2-days/WELL CLUSTER TO CONSTRUCT
(DRILLING & MAT'L COSTS INCLUDED ELSEWH.

MEANS: SITE CREW B-43, B-55, B-61
(SELECTED COMPONENTS)

0.5 LABOR FOREMAN	$74/DAY	BARE COST
3 LABORERS	398/DAY	
1 TRUCK DRIVER (LIGHT)	138/DAY	
1 CEMENT MIXER 2CYD	200/DAY	
1 WATER TRUCK	150/DAY	
1 STEAM CLEANER	75/DAY	
	$1,035/DAY	

(2 DAYS x 7 CLUSTERS x $1,035/DAY) = $14,490

(20) ~~GEOPHYSICAL~~ or BORE HOLE TESTING, ETC

ASSUME $~~15,000~~ ~~Dele~~

AR300948

Baker Engineers

S.O. No. 15438-17-SR [illegible]

Subject: BERKS SAND PIT

MONITORING WELL SYSTEM — Sheet No. 1 of 2

FS- O&M COST — Drawing No.

Computed by LJS Checked By RPH Date 6/20/88

REVISION DATE: 6/29/88

Revised 9/8/88

① OPERATING LABOR (SAMPLING) Delete

COLLECT: 45 SAMPLES 3 TIMES/YEAR (QUARTERLY)

98 SAMPLES 1 TIME/YEAR (ANNUAL)

- 18 RESIDENTIAL WELLS
- 40 MONITORING WELLS
- 20 SURFACE WATER
- 20 SEDIMENT

4 MAN SAMPLING CREW (2 PROFESSIONALS, 2 TECHNICIANS)

ANNUAL	QUARTERLY
2-HR. PURGE	1-hr PURGE
1-HR SET-UP	1-HR OTHER
1/2-HR DECON	2-HR/SAMPLE
1/2-HR TEAR-DOWN	
4-HR/SAMPLE	

(98 x 4) + (45 x 3 x 2) = 662 HR + TRAVEL, ETC.

(700 HR)

PROFESSIONALS $85/HR x ~~700~~ 400 = $59,500

TECHNICIANS $70/HR x ~~700~~ 400 = $49,000

$108,500

~~② OPERATING LABOR (DATA VALIDATION ON ANNUAL SAMPLES)~~

~~2 1/2 HR/SAMPLE DONE ON COMPUTER~~

~~(98 SAMPLES x 2.5) = 245 HR.~~

DELETE

~~{$5/HR COMPUTER, $45/HR PROFESSIONAL} x 245 HR = $12,250~~

~~MGMT. 8 HR x $75/HR, CLERICAL 8 HR x $25/HR } $800~~

TOTAL $13,050

AR300949

③ ANALYTICAL COSTS

QUARTERLY ~~45~~ 100 SAMPLES x \$150/EACH = \$6,750

~~ANNUAL 98 SAMPLES x \$2,310/EA = \$226,380~~

DELETE

"CLP" {INORGANICS / ORGANICS} (\$630 + \$1,680) = \$2,310 / ~~SAMPLE~~

④ REDEVELOPMENT OF MONITORING WELLS

ONCE EACH 5 YEARS
40 M. WELLS.

3 ~~5~~ HR/WELL x \$175/HR x $\frac{40}{5}$ = \$7,000 /YEAR

⑤ ENGINEERING
TO REVIEW & INTERPRET MONITORING DATA

- PROFESSIONAL 80HR x \$45/HR = \$3,600
- Mgmt 8 HR x \$75/HR = \$600
- CLERICAL 8 HR x \$25/HR = \$200
- DRAFTING 16 HR x \$40/HR = \$640

\$5,040

⑥ Decommissioning

X(F/U, 30-YR, 10%) = \$1,601,879
164.491

X = \$9,738/YR SINKING FUND

AR300950

ORIGINAL (Red)

BERKS SAND PIT RI FS MONITORING WELL SYSTEM CAPITAL COSTS
[illegible] BERKMWS2.WK1

ITEM DESCRIPTION	QUANTITY	UNITS	UNIT COST	REFERENCE/SOURCE	ITEM TOTAL ($)
1) EQUIPMENT MOBILIZATION 2 DRILL RIGS 1 STEAM CLEANER 1 WATER TRUCK 1 FLATBED TRUCK 1 105 HP DOZER (<25 MILE MOB.)	1	EA	$10,000.00	BASED ON VARIOUS MEANS ITEMS AND EXPERIENCE	10,000
2) DEMOBILIZATION EQUIPMENT & SITE CLEANUP AT 100% OF MOBILIZATION	1	EA	$10,000.00	ASSUMED	10,000
3) SITE PREPARATION CLEAR AND GRUB (LIGHT TREES)	2	ACRES	$1,[illegible]	MEANS/SITE 021-104-[illegible]	[illegible]
4) DRILLING [illegible] DIA HOLE NO CASING, LABOR EQUIP. ONLY	[illegible],800	VLF	$7.28	MEANS/SITE [illegible]	27,664
5) DRILLING NX CORES	[illegible]	[illegible]	[illegible]	MEANS SITE [illegible]	[illegible]
6) CORE BOXES FOR CORE SAMPLES 10 LF [illegible] WOOD FOB AT SITE	[illegible]	EA	$50.00	ASSUMED	6,[illegible]
7) PIPE, [illegible] DIA STEEL CASING	[illegible]	LF	[illegible]	MEANS/SITE [illegible]	[illegible]
8) PIPE, 4" DIA. SOLID PVC CASING	[illegible]	LF	[illegible]	MEANS SITE [illegible]	[illegible]
9) WELL SCREEN, 4" DIA. PVC FACTORY SLOTTED	[illegible]	LF	$14.00	VENDER QUOTE	[illegible],600
10) FITTINGS					0
4" DIA PVC CAPS, EXTENDER PIPE	21	EA	$50.00	ASSUMED	1,050
LOCKING WELLHEAD STEEL CAPS	21	EA	$[illegible].00	ASSUMED	[illegible]
11) CONCRETE, FOR WELL CLUSTER PADS	5	CYD	$93.05	MEANS/SITE 033-130-4650	465
12) PORTLAND CEMENT, FOR GROUT	923	BAG	$6.00	MEANS SITE,033-[illegible]	[illegible]
13) BENTONITE, FOR GROUT	30	BAG	$9.50	MEANS SITE/071-[illegible]-0300	[illegible]
14) SAND, PACKING AT WELL SCREENS	20	CYD	$15.40	MEANS,SITE,[illegible]-0300	[illegible]
15) BENTONITE PELLETS	30	PAILS	$60.00	ASSUMED	1,800

16) PROFESSIONALS - ON SITE					
A GEOLOGIST COORDINATOR	[illegible]	HOUR	$[illegible]	ESTIMATED	[illegible]
B HEALTH SAFETY OFFICER	120	HOUR	$70.00	ESTIMATED	8,400
(C) GEOLOGIST	510	HOUR	$60.00	ESTIMATED	30,600
17) PACKER TESTS AT 1 WELL/CLUSTER					
1 DAY PER WELL BEING TESTED	56	HR	$200.00	VENDER QUOTE	11,200
ANALYTICS: 5 SAMPLES PER HOLE	35	SAMPLES	$150.00	ESTIMATED	5,250
18) WELL DEVELOPMENT 3HR/WELL, 21 WELLS	63	HR	$175.00	VENDER QUOTE	11,025
19) WELL CONSTRUCTION [illegible] DAYS/WELL					
LABOR EQUIP. ONLY, SELECT CREW	14	CREW-DAYS	$450.00		6,300
20) GEOPHYSICAL BORE HOLE TESTING	1	EA	$7,500.00	ASSUMED	7,500
					0
21) PRE-START UP WATER ANALYTICS					0
	50	TESTS	$150.00	VENDER QUOTE	7,500
					0
22) GEOPHYSICAL SITE INVESTIGATION	1	EA	$25,000.00	ASSUMED	25,000
					0
23) PUMP TESTS					0
	[illegible]	HR	$200.00	ASSUMED	4[illegible],000
					0
24) INTENTIONALLY BLANK					0
					0
					0
25) TREATMENT OF PUMP TEST WATERS					0
A SWIMMING POOLS	2	EA	$2,000.00	VENDER QUOTE	4,000
B ACTIVATED CARBON CANISTERS	4	EA	$500.00	VENDER QUOTE	2,000
C ACCESSORIES: PIPING, ETC.	1	EA	$1,500.00	ASSUMED	1,500
D SITE PREPARATION TEAR-DOWN	20	MAN-DAYS	$200.00	MEANS SITE/CREW [illegible]	4,000
E GENERATOR - 3 KW, GAS	30	RENT-DAY	$28.00	MEANS SITE/016-400-2100	840
F TRASH PUMP - 2", GAS	60	RENT-DAY	$26.00	MEANS SITE/016-400-5500	1,560
G DISPOSAL OF A.C. CANISTERS					0
INCINERATION	4	EA	$500.00	ASSUMED	2,000
26) STREAM CHARACTERIZATION STUDY	1	EA	$10,000.00	ASSUMED	10,000
					0
A SUB-TOTAL (A)					$4[illegible]3,870
B SUBCONTRACTORS WORK					
ESTIMATED AT 20% OF SUB-TOTAL					$87,174
FEE AT 10% OF SUB. WORK					$8,717

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C) SUB-TOTAL (B) = (A) + FEE					$444,587
D) CITY COST INDEX ADJUSTMENT AT 0.949 AVGERAGE FOR READING, PENNSYLVANIA APPLIED TO SUBTOTAL (B)				BASED ON MEANS SITE/CITY COST INDEX,APPENDIX 1988, FOR READING, PA	$421,913
E) TOTAL ADJUSTED DIRECT COSTS (TADC)					$421,913
F) INDIRECT CONTRACTOR COSTS AT 35% OF TADC				BASED ON MEANS/SITE/APPX.	$147,670
G) CONTRACTOR PROFIT AT 10% OF TADC + INDIRECT					$56,958
H) TOTAL FIELD COST (TFC)					$626,541
I) HEALTH AND SAFETY COST ALLOWANCE AT 5% OF TFC					$31,327
J) CONTINGENCY COST AT 20% OF TFC					$125,308
K) ENGINEERING COST AT 10% OF TFC					$62,654
L) TOTAL CAPITAL COST TFC + H.S + CONT + ENG					$845,831

ORIGINAL (Red)

SYSTEM, MONITORING WELL SYSTEM OPMW82.WK1

BERKS SAND PIT ANNUAL OPERATION COSTS

NO.	ITEM DESCRIPTION	ANNUAL QUANTITY	UNITS	UNIT COST	ANNUAL COST
1)	OPERATING LABOR				
	(A PROFESSIONALS (2) FOR SAMPLING	760	HR	$70.00	$53,200
	(B TECHNICIANS (2) FOR SAMPLING	760	HR	$60.00	$45,600
	(C				
2)	ANALYTICAL TESTING				
	A ~~QUARTERLY~~ ANNUAL	95	TESTS	$150.00	$14,250
	B				
	C				
3	WELL MAINTENANCE				
	A REDEVELOPMENT EVERY 5-YEARS 40 WELLS TOTAL 3-HR. PER WELL	24	HR	$175.00	$4,200
	B				
4	AUXILIARY MATERIALS LABOR				
	A				
	B				
	C				
5	PURCHASED SERVICES				
	A				

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6) DISPOSAL				
7) ADMINISTRATION				
a REVIEW MONITORING DATA				
PROFESSIONAL	80	HR	$55.00	$4,400
MANAGEMENT	8	HR	$75.00	$600
DRAFTING	16	HR	$40.00	$640
CLERICAL	8	HR	$25.00	$200
COMPUTER	60	HR	$10.00	$600
8) INSURANCE,TAXES,LICENSES				
9) [illegible]				
SUBTOTAL (A)				$123,690
B CONTINGENCY COST AT 20% OF SUBTOTAL(A				$24,738
C SALVAGE AND DECOMMISSION: AT 100% CAPITAL COSTS INCURRED AT 30-TH YEAR,				

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INTEREST = 10% ANNUAL SINKING PAYMENT	$94[illegible]			$5,[illegible]	
D) ANNUALIZED CAPITAL COST				$154,151	
E) PRESENT WORTH AT 10% INTEREST AT 30 YEARS				$1,453,165	

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EXTRACTION WELL SYSTEM